Installation Planning

Infinity$_{plus}$ *NMR Spectrometer Systems*

Pub. No. 01-999176-00, Rev. B1001

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Agilent Technologies

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VARIAN

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Infinityplus™ NMR Spectrometer Systems
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SAFETY PRECAUTIONS

The following warning and caution notices illustrate the style used in Varian manuals for safety precaution notices and explain when each type is used:

WARNING: ***Warnings*** **are used when failure to observe instructions or precautions could result in injury or death to humans or animals, or significant property damage.**

CAUTION: ***Cautions*** **are used when failure to observe instructions could result in serious damage to equipment or loss of data.**

Warning Notices

Observe the following precautions during installation, operation, maintenance, and repair of the instrument. Failure to comply with these warnings, or with specific warnings elsewhere in Varian manuals, violates safety standards of design, manufacturing, and intended use of the instrument. Varian assumes no liability for customer failure to comply with these precautions.

WARNING: **Persons with implanted or attached medical devices such as pacemakers and prosthetic parts must remain outside the 5-gauss perimeter from the centerline of the magnet.**

The superconducting magnet system generates strong magnetic fields that can affect operation of some cardiac pacemakers or harm implanted or attached devices such as prosthetic parts and metal blood vessel clips and clamps.

Pacemaker wearers should consult the user manual provided by the pacemaker manufacturer or contact the pacemaker manufacturer to determine the effect on a specific pacemaker. Pacemaker wearers should also always notify their physician and discuss the health risks of being in proximity to magnetic fields. Wearers of metal prosthetics and implants should contact their physician to determine if a danger exists.

Refer to the manuals supplied with the magnet for the size of the specific 5-gauss stray field. This gauss level should be checked after the magnet is installed.

WARNING: **Keep metal objects outside the 10-gauss perimeter from the centerline of the magnet.**

The strong magnetic field surrounding the magnet attracts objects containing steel, iron, or other ferromagnetic materials, which includes most ordinary tools, electronic equipment, compressed gas cylinders, steel chairs, and steel carts. Unless restrained, such objects can suddenly fly towards the magnet, causing possible personal injury and extensive damage to the probe, dewar, and superconducting solenoid. The greater the mass of the object, the more the magnet attracts the object.

Only nonferromagnetic materials—plastics, aluminum, wood, nonmagnetic stainless steel, etc.—should be used in the area around the magnet. If an object

Warning Notices (*continued*)

is stuck to the magnet surface and cannot easily be removed by hand, contact Varian service for assistance.

Refer to the manuals supplied with the magnet for the size of the specific 10-gauss stray field. This gauss level should be checked after the magnet is installed.

WARNING: **Only qualified maintenance personnel shall remove equipment covers or make internal adjustments.**

Dangerous high voltages that can kill or injure exist inside the instrument. Before working inside a cabinet, turn off the power switch located on the back of the console and/or the power switch on the individual high-power amplifier, then disconnect the ac power cords. If you are unsure of the location for the power switches contact your Varian, Inc. service representative.

WARNING: **Do not substitute parts or modify the instrument.**

Any unauthorized modification could injure personnel or damage equipment and potentially terminate the warranty agreements and/or service contract. Written authorization approved by a Varian, Inc. product manager is required to implement any changes to the hardware of a Varian NMR spectrometer. Maintain safety features by referring system service to a Varian service office.

WARNING: **Do not operate in the presence of flammable gases or fumes.**

Operation with flammable gases or fumes present creates the risk of injury or death from toxic fumes, explosion, or fire.

WARNING: **Leave area immediately in the event of a magnet quench.**

If the magnet dewar should quench (sudden appearance of gasses from the top of the dewar), leave the area immediately. Sudden release of helium or nitrogen gases can rapidly displace oxygen in an enclosed space creating a possibility of asphyxiation. Do not return until the oxygen level returns to normal.

WARNING: **Avoid liquid helium or nitrogen contact with any part of the body.**

In contact with the body, liquid helium and nitrogen can cause an injury similar to a burn. Never place your head over the helium and nitrogen exit tubes on top of the magnet. If liquid helium or nitrogen contacts the body, seek immediate medical attention, especially if the skin is blistered or the eyes are affected.

WARNING: **Wear eye protection when spinning a sample with the probe outside the magnet.**

A rotor crash can shatter a rotor and cause eye injury when spinning a sample in a probe that is not installed in a magnet. Wear eye protection.

WARNING: **Support the magnet and prevent it from tipping over.**

The magnet dewar has a high center of gravity and could tip over in an earthquake or after being struck by a large object, injuring personnel and causing sudden, dangerous release of nitrogen and helium gasses from the dewar. Therefore, the magnet must be supported by at least one of two methods:

Warning Notices (*continued*)

with ropes suspended from the ceiling or with the antivibration legs bolted to the floor.

WARNING: **Do not remove the relief valves on the vent tubes.**

The relief valves prevent air from entering the nitrogen and helium vent tubes. Air that enters the magnet contains moisture that can freeze, causing blockage of the vent tubes and possibly extensive damage to the magnet. It could also cause a sudden dangerous release of nitrogen and helium gases from the dewar. Except when transferring nitrogen or helium, be certain that the relief valves are secured on the vent tubes.

Caution Notices

Observe the following precautions during installation, operation, maintenance, and repair of the instrument. Failure to comply with these cautions, or with specific cautions elsewhere in Varian manuals, violates safety standards of design, manufacturing, and intended use of the instrument. Varian assumes no liability for customer failure to comply with these precautions.

CAUTION: **Keep magnetic media, ATM and credit cards, and watches outside the 5-gauss perimeter from the centerline of the magnet.**

The strong magnetic field surrounding a superconducting magnet can erase magnetic media such as floppy disks and tapes. The field can also damage the strip of magnetic media found on credit cards, automatic teller machine (ATM) cards, and similar plastic cards. Many analog wrist and pocket watches are also susceptible to damage from intense magnetism.

Refer to the manuals supplied with the magnet for the size of the specific 5-gauss stray field. This gauss level should be checked after the magnet is installed.

CAUTION: **Keep the PCs, beyond the 5-gauss perimeter of the magnet.**

Avoid equipment damage or data loss by keeping PCs well away from the magnet. Generally, keep the PC beyond the 5-gauss perimeter of the magnet. Refer to the *Installation Planning Guide* for magnet field plots.

CAUTION: **Never operate solids high-power amplifiers with liquids probes.**

Never operate the solids high-power amplifiers with a liquids probe. The high power available from these amplifiers can easily destroy liquids probes. Use the appropriate high-power probe with the high-power amplifier.

CAUTION: **Take electrostatic discharge (ESD) precautions to avoid damage to sensitive electronic components.**

Wear a grounded antistatic wristband or equivalent before touching any parts inside the doors and covers of the spectrometer system. Also, take ESD precautions when working near the exposed cable connectors on the back of the console.

Radio-Frequency Emission Regulations

The covers on the instrument form a barrier to radio-frequency (rf) energy. Removing any of the covers or modifying the instrument may lead to increased susceptibility to rf interference within the instrument and may increase the rf energy transmitted by the instrument in violation of regulations covering rf emissions. It is the operator's responsibility to maintain the instrument in a condition that does not violate rf emission requirements.

Introduction

This guide assists in selecting and preparing a site to install a Varian *Infinityplus* NMR superconducting spectrometer system, including preparing the Sun workstation. Using the predelivery and postdelivery checklists provided and following the information presented should bring about a smooth transition from delivery to installation. Figure 1 illustrates a *Infinityplus* cabinet and an Oxford magnet.

This guide contains the following chapters:

- Chapter 1, "Site Selection and System Delivery," describes how to plan for the installation of an NMR spectrometer. This chapter also discusses system delivery and provides a table of shipping dimensions for NMR components. Begin in this chapter.
- Chapter 2, "Installation Site Requirements," lists the factors to consider when selecting the installation site.
- Chapter 3, "Site Preparation," describes the many factors to consider—electrical, cooling, safety, supplies, and so forth—when preparing the installation site.
- Chapter 4, "Installation Supplies," describes the supplies required and recommended for the system installation.
- Chapter 5, "Stray Magnetic Fields," provides magnetic field safety hazard data and shows stray field plots for each magnet system.
- Chapter 6, "Room Layouts," provides information for laying out the NMR room.

Importance of Communication

In planning the system installation, good communications are essential between the customer, the facility planner or architect, and Varian on a frequent basis. Any questions or problems must be addressed immediately to avoid delays and additional costs. One person

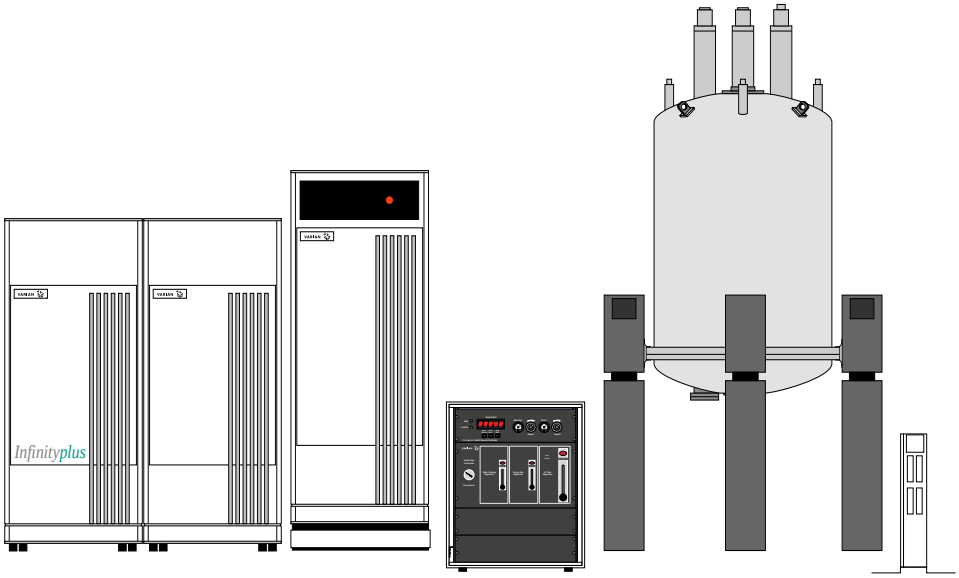

Figure 1. *Infinityplus* Cabinet and Oxford Magnet

from the customer's institution should be appointed to coordinate site planning and preparation. This person should represent all users of the system in dealing with Varian and the facility planner or architect.

Contacting Varian

Varian's staff of thoroughly trained service specialists throughout the world is your assurance of always receiving prompt attention. You can access information at `www.varianinc.com/nmr` using the Contact Us button or:

For product sales and service information, contact one of the Varian sales offices:

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We at Varian will make every effort to ensure that the ownership of your new NMR spectrometer is a lasting, productive, and pleasurable experience.

Chapter 1. Site Selection and System Delivery

Sections in this chapter:

- 1.1 “Installation Planning Process” this page
- 1.2 “Site Selection” page 14
- 1.3 “Transport Route and System Shipping Dimensions” page 15
- 1.4 “System Shipment” page 16

Varian’s delivery responsibility ends at the Varian factory shipping dock or at the customer’s receiving dock, depending upon the type of insurance obtained by the customer. In either case, for 200- through 600-MHz magnets, the customer must provide a moving crew to move the shipping crates holding the system from the delivery truck (or storage location) to the installation site. For 750-MHz magnets and larger, depending on contract terms, Varian may provide a moving crew.

1.1 Installation Planning Process

Use the following steps to prepare for delivery of the system. Refer to the chapters in this guide for further details. Consult knowledgeable individuals, such as plant facilities personnel, for assistance in implementing these instructions.

1. Check the “SHIP BY” date on the Varian Order Acknowledgment form. Use this date as a target for completing installation preparations. If you anticipate any delays in site readiness and need to delay shipment, notify the factory at *least* 90 days in advance. Select the site for installing and operating the system. (Note: a site survey is standard with most *Infinity*$_{plus}$ spectrometer systems.)

   Review the considerations described in Section 1.2 on page 14 and make sure the site conforms to the requirements listed in Chapter 2, “Installation Site Requirements,” on page 19.

2. Prepare the installation site, including electrical outlets, compressed air supply, and air conditioning as described in Chapter 3, “Site Preparation,” on page 29. Make any computer preparations required, also described in Chapter 3 .

3. Order supplies and equipment for installation and startup operation, as described in Chapter 4, “Installation Supplies,” on page 39.

4. Make arrangements for workers and equipment to move the system upon delivery to the installation site, as described in Section 1.4, “System Shipment,” on page 16.

5. Read carefully, sign, and mail to Varian the “Object Code License Form.” (Note that acceptance of the products on the Order Acknowledgment form constitutes acceptance of the terms stated in the Object Code License Form, whether the form is signed or not.)

1.2 Site Selection

Site selection is the process of finding a location for the magnet providing the least interference from the building it occupies. The selection of an optimum site is determined almost entirely by the high magnetic fringe field of the system. The process of selection can be complex because of the interaction of the magnetic field with the surrounding environment. Chapter 2, “Installation Site Requirements,” describes in detail all the factors to consider when selecting a site.

1. Begin by looking for a site with a series of general requirements in mind. The placement of the magnet is the primary consideration:
   - How will the field from the magnet affect its neighbors?
   - What will the building and its contents do to the quality of the magnet field?
   - Can the system be delivered to the site?
2. The second requirement is access:
   - Will the site limit public access in surrounding areas?
   - Can magnetic storage media be taken to the area safely?
   - Can cryogen transfers be made quickly and safely?
3. Finally, look at the area as a whole with the following considerations:
   - Look for an area large enough to contain the magnet and as much of the 5-gauss static field as possible. The area should have the minimum ceiling height described in Section 2.3, “Ceiling Height Requirements,” on page 21.
   - When an acceptable space has been found, look for steel and iron in the immediate area. Consider the structural steel of the building, iron pipes, machinery, etc.
   - Look in the near area for elevators, vehicular traffic, large transformers, and other large amounts of steel and iron.
   - Consider the ability to control the movement of ferromagnetic objects, such as elevators, automobiles, or carts, within the magnetic field.
   - Consider adequate access for the delivery of dewars containing liquid helium and nitrogen.
   - Consider public access that might pass through the 5-gauss zone.
   - Consider escape routes in case of emergency, including a magnet quench.
   - Consider the location of sensitive electronic equipment that might be affected by the magnetic field. This includes dryers, compressors, and other such equipment. See Section 2.7, “Magnetic Environment,” on page 23 and Chapter 5, “Stray Magnetic Fields,” on page 43.
   - For an exact definition of gauss line boundaries, refer to Section 5.2, “Stray Field Plots,” on page 44 for more information.
   - Make sure you have enough ventilation in case of a quench. Refer to Section 2.9, “Ventilation,” on page 26.

1.3 Transport Route and System Shipping Dimensions

If possible, move the crates with a forklift or hydraulic pallet mover directly to the installation site. The crates must remain upright.

CAUTION: **Move the crates in an upright position. Do not drop or mishandle. The crates are packed with G-force and "tip-and-tell" indicators that record mishandling. Be especially careful about moving the magnet crate. If one or more crates cannot be moved into the installation site because of doorway clearance, leave the affected crates in a clean, safe, dry location. Do not open any crate except with direct instructions from an authorized Varian representative.**

The installation site must be accessible from the delivery location with adequate clearance for system crates and moving equipment (including magnet hoist) throughout the access route. Refer to Table 1, Table 2, and Table 3 for the dimensions and weights needed for calculating vertical, horizontal, and turning clearances, and evaluating the structural strength of passageways. Moving the larger crates of the system requires a forklift or hydraulic pallet mover, which must be considered when calculating accessibility.

Table 1. Magnet Dimensions as Shipped with Crate and Pallet

Magnet/Bore (MHz/mm)*	*Height** cm (in.)*	*Width** cm (in.)*	*Depth** cm (in.)*	*Weight** kg (lb)*
200/89	185 (73)	94 (37)	128 (50.5)	456(1003)
300/89	185 (73)	94 (37)	128 (50.5)	464 (1021)
400/89 AS	185 (73)	94 (37)	128 (50.5)	571 (1259)
500/89 AS	203 (80)	123 (44)	152 (60)	1049 (2308)
600/89	203 (80)	94 (37)	128 (50.5)	781 (1722)
800/63 (2.2 K)	290 (114)	210 (84)	210 (84)	3000 (6600)

* Actively shielded magnets are designated by "AS".
** Dimensions and weights are typical and can vary ±5 cm (±2 in.) or ±4.5 kg (±10 lb) from crate to crate.

Table 2. Cabinet Dimensions as Shipped, with Crate and Pallet

Cabinet	*Height cm (in.)*	*Width cm (in.)*	*Depth cm (in.)*	*Weight kg (lb)*
Infinityplus console	158 (62)	125 (49)	104 (41)	~ 354 (~ 780)
Infinityplus amplifier cabinet 1 cabinet for 1–3 channels 2 cabinets for 4 channels	168 (66)	71 (28)	112 (44)	~ 313 (~ 690)

For an installation site at a different level from the delivery location, be sure that the lifting equipment (such as a forklift or an elevator) is capable of handling the combined weight and size of the shipping crates and the moving equipment.

Table 3. System Accessories Dimensions as Shipped with Crates and Pallets as Appropriate

Accessory	*Height cm (in.)*	*Width cm (in.)*	*Depth cm (in.)*	*Weight kg (lb)*
Accessory cabinet	94 (37)	72 (28)	97 (38)	90 (198)
Miscellaneous Crate	145 (57)	130 (51)	104 (41)	154 (339)
NMR work table	31 (12)	188 (74)	115 (45)	89 (196)

If it is not possible to gain access to the installation site unless the system is uncrated, contact a Varian representative for further instructions. Do not uncrate the system except upon direct instructions from an authorized Varian representative.

To avoid unnecessary expense, be sure moving personnel and equipment are ready for the shipment on the delivery day.

1.4 System Shipment

The method of shipping and the current conditions at the destination determine the extent of the receiving preparations. The Varian Order Acknowledgment form indicates the shipping method for the order. The following service is usually provided:

- *Air Freight.* System is delivered to unloading dock or other easily accessible outside unloading point. Factory to destination transit time is about two days (not including time to clear customs).
- *Motor or Moving Van.* System is delivered to an easily accessible interior location or any interior location to which freight can be easily transported by movable dolly. Excluded is transport in elevators that cannot support the weight of the shipment or up stairways. Factory to destination within the United States is about eight days.

Selecting a Local Shipping Company

Confirm that the local shipping company uses a vehicle that will allow the magnet to be transported in an *upright* position for all transport methods that will be used. See Table 1, Table 2, and Table 3 for dimensions and weights of major system components.

Contact the shipping company locally about the service usually rendered. If moving equipment will be required at the site, obtain help from the plant facilities department or an outside moving service. Sea freight or motor freight without air cushion suspension is not recommended for long distance delivery of systems.

Postdelivery Inspection

When the system is delivered, follow the instructions below to inspect for shipping damage before moving the crates. *Do not open any crate.*

CAUTION: **Do *not* open any crate except with direct instructions from an authorized Varian service representative. In particular, the crate containing the magnet has components that could be irreparably damaged if opened incorrectly.**

1. Upon delivery, check for shipping damage but do not open any shipping crates except with direct instructions from an authorized Varian service representative. Examine crates for shipping damage and document any apparent damage as follows:

   a. Note the nature of the damage on the carrier's waybill.

   b. Request an inspection and written damage report by a representative of the carrier.

   c. Contact the insurance company.

   d. Forward a copy of the damage report to the local Varian representative.

   In case of damage, the FOB block on the Varian Order Acknowledgment form determines owner responsibility:

   - *FOB PALO ALTO or FORT COLLINS.* Transfer of ownership occurs when the shipment leaves the factory. The customer is responsible for claims for shipping damage. Upon request, Varian will provide assistance in filing claims.
   - *FOB DESTINATION.* Transfer of ownership occurs at customer's point of receipt. Varian is responsible for claims for shipping damage.

   Damage discovered fifteen or more days after delivery generally cannot be recovered. Such damage will be at the expense of the customer.

2. As soon as possible, move the shipment to a clean, dry location (preferably the installation site). Move the crates in an upright position. Do not drop or mishandle. The crates are packed with G-force and "tip-and-tell" indicators that record mishandling. If one or more crates cannot be moved into the installation site because of doorway clearance, leave the affected crate in a clean, safe, dry location. Again, do not open any crate except with direct instructions from an authorized Varian representative. *In particular, the crate containing the magnet has components that could be irreparably damaged if opened incorrectly.*

3. Contact Varian to schedule the visit of an installation engineer after the shipment is moved to the installation site, the utilities are installed, and non-Varian installation parts and supplies (listed in the "Installation Supplies and Equipment" section) are received. For installations in the United States, telephone the Installation Department at (650) 424-4587.

Chapter 2. Installation Site Requirements

Sections in this chapter:

- 2.1 “Site Size” this page
- 2.2 “Accessibility of Site” page 20
- 2.3 “Ceiling Height Requirements” page 21
- 2.4 “Structural Strength of Floor” page 21
- 2.5 “Floor Vibration Level Requirements” page 23
- 2.6 “Magnet Support Requirement” page 23
- 2.7 “Magnetic Environment” page 23
- 2.8 “Radio-Frequency Interference In-Band” page 25
- 2.9 “Ventilation” page 26
- 2.10 “Ambient Temperature and Humidity” page 26
- 2.11 “Helium and Nitrogen Refill Volumes and Intervals” page 27

The *Infinityplus* NMR spectrometer has certain site requirements, which are described in this chapter. Factors to consider when selecting the installation site include:

- Site size and ceiling height
- Accessibility to the delivery location
- Floor rigidity and structural strength
- Magnetic and radio frequency environment
- Air ventilation, ambient temperature, and humidity

2.1 Site Size

The site must be large enough to allow free access to all sides of the cabinet, magnet, and accessories for operation, maintenance, and cryogenic service. Table 4, Table 5, and Table 6 list the dimensions of the system components, and Chapter 6, “Room Layouts,” on page

Table 4. *Infinityplus* Cabinets Dimensions and Weights

System	*Height cm (in.)*	*Width cm (in.)*	*Depth cm (in.)*	*Weight kg (lb)*
Infinityplus console	124.5 (49)	110.7 (43.6)	78 (30.7)	~ 281 (~ 620)
Infinityplus amplifier cabinet 1 cabinet for 1–3 channels 2 cabinets for 4 channels	142.3 (56)	55.3 (21.8)	78 (30.7)	~ 272 (~ 600)

Table 5. Magnet Dimensions with Stand or Legs Attached

Magnet/Bore (MHz/mm)	*Height cm (in.)*	*Width cm (in.)*	*Depth cm (in.)*	*Magnet Weight kg (lb)*	*Weight with Antivibration kg (lb)*
200/89	230 (90.5)	79 (31)	79 (31)	391 (860)	456 (1005)
300/89	230 (90.5)	79 (31)	79 (31)	399 (878)	506 (1115)
400/89	230 (90.5)	79 (31)	79 (31)	410 (902)	660 (1456)
400/89 AS	230 (90.5)	79 (31)	79 (31)	410 (902)	660 (1456)
500/89 AS	258 (101.6)	98 (38)	98 (38)	—	1250 (2756)
600/89	258 (101.6)	79 (31)	79 (31)	—	796 (1755)
800/63 (2.2K)	349.7 (137.6)	118.3 (46.6)	118.3 (46.6)	—	3000 (6600)

Notes:
1. Dimensions and weights are typical and can vary ±5 cm (±2 in.) or ±4.5 kg (±10 lb) from crate to crate.
2. AS represents actively-shielded magnets
3. Magnets with "—" in the weight column ship standard with the antivibration legs.

Table 6. System Accessories Dimensions and Weights

Configuration	*Height cm (in.)*	*Width cm (in.)*	*Depth cm (in.)*	*Weight kg (lb)*
Accessory cabinet	74 (29.1)	55 (21.7)	78 (30.6)	~68 (~150)
Magnetic Leg	65.5 (26)	41 (16.1)	45.7 (18)	66 (30)
NMR work table	71 (28)	178 (70)	152 (60)	48 (107)

53, contains floor plans for the NMR laboratory area or room. The plans are suggestions and not specifications.

The standard arrangement places the power bay(s) to the right of the console as viewed from the front. However, cable lengths are long enough to allow the power bay(s) to be placed to the left of the console if that orientation works better for a particular site.

All cabinets have casters for easy movement, allowing the system to be placed in a location as small as that illustrated in Chapter 6, "Room Layouts," on page 53, as long as sufficient space exists for the cabinets to be moved to provide for access to all sides. The minimum dimensions do *not* include compensation for external magnetic and rf interference that may be present. When setting up a spectrometer, you should try to keep the 5 gauss line inside the lab. The console, power bay, and workstation must be outside the 5 gauss line, see section 2.7 "Magnetic Environment" page 23. If this criteria can not be met please consult with your Varian representative. Each individual site must be analyzed to ensure optimum system performance.

2.2 Accessibility of Site

The site must provide adequate access for the routine delivery of supply dewars containing liquid helium and nitrogen. The site must also be accessible for system delivery, as described in Section 1.3, "Transport Route and System Shipping Dimensions," on page 15.

2.3 Ceiling Height Requirements

The ceiling must provide sufficient headroom to insert the liquid-helium transfer tube into the magnet dewar and the storage dewar. The height of the ceiling (or that part of the ceiling located directly above the magnet) without obstructions, such as lighting and heating ducts, *must* be equal to or greater than the minimum heights listed in Table 7. If you buy the helium-level option, the helium-level probes are furnished with a flexible section as standard, thus allowing all magnets to be installed within minimum ceiling heights listed in Table 7.

Table 7. Ceiling Minimum Height

Magnet/Bore (MHz/mm)	*Ceiling Minimum cm (in.)**	*Minimum With Hinged Components cm (in.)*
200/89	314 (123.6)	295 (116)
300/89	314 (123.6)	295 (116)
400/89	314 (123.6)	295 (116)
400/89 AS	314 (123.6)	295 (116)
500/89 AS	333 (131)	319(126)
600/89	343 (135)	Not applicable
800/63 (2.2k)	400 (157.5)	Not applicable

* All dimensions include 110 mm to clear the top of the cryostat.

These ceiling minimums allow enough headroom to insert the standard helium flutter tube and refill transfer tubes into the magnet dewar. They also allow use of the standard power stick for running up the magnet field. However, if one of the larger capacity liquid-helium storage dewars is used with the magnet, additional ceiling clearance may be necessary. In general, the ceiling height must be at least twice the height of liquid-helium storage dewar above the floor. Some magnets can be provided with optional hinged top-loading components that reduce the minimum ceiling height requirements. Contact Oxford for details, this must be specified when ordering the magnet.

Leg antivibration (i.e., vibration isolation) systems do not increase the ceiling height requirements. Table antivibration systems add 20.32 cm (8 in.).

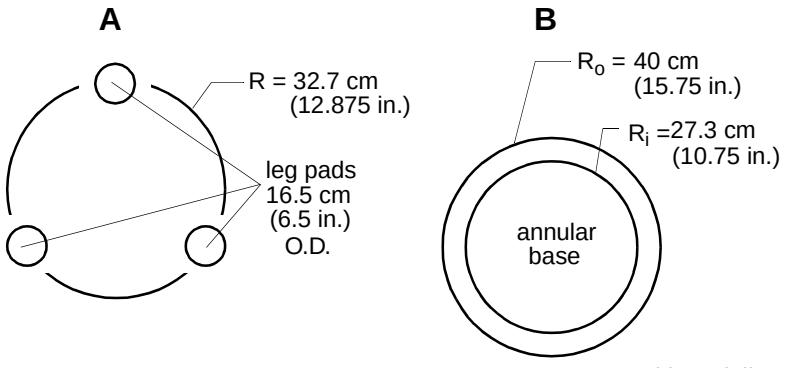
2.4 Structural Strength of Floor

Contact a plant engineer, structural engineer, or registered civil engineer to confirm that the magnet (and antivibration system as applicable) does not exceed the structural floor loading rating. The site floor also must have sufficient structural strength to support the combined weight of the entire spectrometer system and all moving equipment during installation. Table 4, Table 5, and Table 6.

Magnet Weight Distribution, With No Antivibration System

This section describes weight distribution for magnets without antivibration systems. The weights of the magnets, including stands, are given in Table 5.

200/89, 300/89, 400/89, and long-hold magnets – The stands for these magnets consist of three legs, as shown in the plan view in Figure 2A. Because the legs are hollow, the surface contact with the floor is only 167.74 cm^2 (26 sq. in.) total, which creates relatively high “point loading.” This loading is only a concern if the floor covering is soft.



Magnets:
200/89
300/89
400/89
LH magnets

Magnets with antivibration tires:
200/89
300/89
400/89
400/89AS

Figure 2. Plan Views of Floor Contact Points of Magnet Stands

Magnet Weight Distribution, With Antivibration System

This section describes weight distribution for magnets installed with antivibration systems. Magnet weights, including stands and antivibration systems, are listed in Table 5.

200/89, 300/89, 400/89, 500/89, 600/89, and 800/63 magnets – The antivibration system for these magnets consists of dampening equipment integrated into the magnet legs. All of these magnets are supported by three legs, as illustrated in Figure 3A, Figure 3B, and Figure 3C.

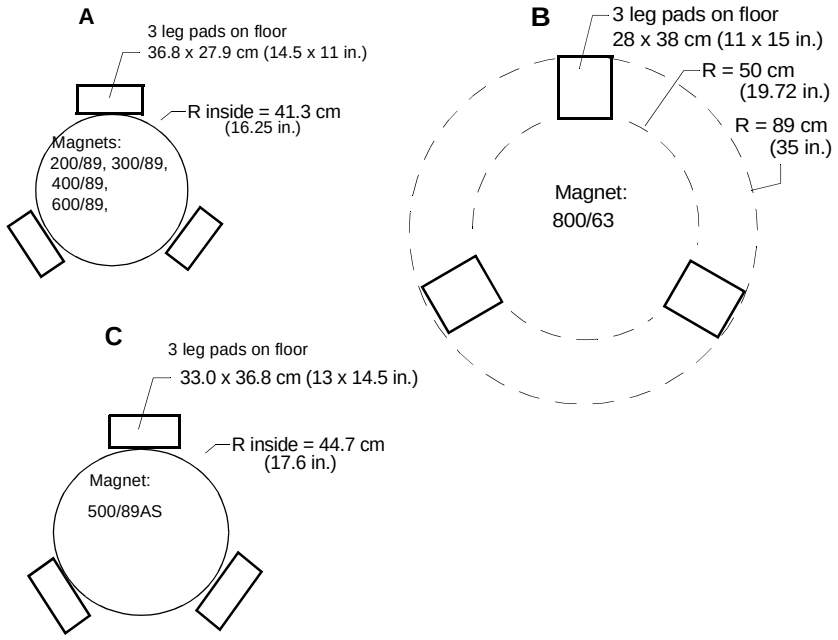


Figure 3. Magnet Leg Antivibration Systems Leg Placement and Sizes

2.5 Floor Vibration Level Requirements

The floor must be sufficiently rigid to reduce the vibration from adjacent dynamic loads to a negligible level, defined as no single peak vibration greater than 20 µg acceleration from 5 to 100 Hz. For sites exceeding this specification, antivibration equipment is necessary. Sites with vibrations below 5 Hz exceeding 5 µg are not recommended for the installation of any spectrometers. Use of Firestone tire antivibration systems are not generally recommended at sites with vibrations below 20 Hz or at any site with large vibrations in the horizontal direction. Ground floor or basement sites are generally preferred for systems because the natural resonant frequencies of most building structures are typically at low frequencies and horizontal in direction.

Measurements are made with an analyzer (Ono Sokki Model CF 200 field FFT analyzer, Hewlett-Packard Model 3561A signal analyzer, or equivalent) using 16 RMS time averages and with a seismic accelerometer that has 10 V/g sensitivity (Wilcoxen Model 731 or equivalent).

2.6 Magnet Support Requirement

The magnet has a high center of gravity and could tip over during an earthquake or after being struck by a large object. Therefore, the magnet must be supported either by ropes attached to the ceiling or by bolting the magnet legs to the floor. Magnet dimensions and weights are listed in Table 5. A structural engineer should be contacted to determine the best restraint method that meets local seismic requirement variations. If overhead ropes are used, the ceiling of the building should be evaluated for structural strength. The ropes should have a small amount of slack so that building vibrations are not transmitted to the magnet. These vibrations can cause artifacts to appear in the NMR spectra.

Floor Anchoring Requirements

All systems with antivibration legs must be anchored to the floor. The antivibration system used incorporates the dampening mechanism as an integral part of the magnet leg. As a result the legs are not rigidly attached to the magnet. In order to work properly they must be firmly attached to the floor. This floor attachment also prevents the tipping of the leg in the case of an earthquake or being struck by a large object. Depending on the seismic requirement, the size of the magnet and the floor material, floor anchoring alone may not be adequate. A structural engineer should be contacted for recommendations. Anchoring to the floor is a standard procedure for many other types of equipment.

Varian expects that the customer’s plant or maintenance personnel can usually accomplish anchoring the leg. Varian supplies four 1/2-inch diameter anchor bolts for each leg. A minimum depth of 2.5 in is required for each bolt.

2.7 Magnetic Environment

The site must have a minimum of environmental magnetic fields. Common sources of magnetic interference are fluctuating loads on adjacent power lines, radio or television transmissions, heavy-duty transformers, elevator motors, and similar electromagnetic devices. Allow a separation of at least 4.6 m (15 ft.) between the magnet and other high-field electromagnets, elevators, or forklift trucks.

Similar separation distances must also be maintained between the magnet and anything that can cause a detrimental effect on the field homogeneity or the structural integrity of the magnet. Conditions that could interfere with the magnet include (but are by no means limited to) a wall with metal sheathing or steel studding, a concrete support column with steel reinforcing bars, and a storage area containing steel dewars for cryogenic storage. Each site must be carefully analyzed to ensure optimum performance of the system. See Table 8 for examples of objects that affect or are affected by the magnetic field. Stray field data for radial and axial distances for each magnet are given in Table 23.

Table 8. Interaction Between a Magnetic Field and Common Objects

Magnetic Field	*Objects That Affect the Magnetic Field*
15 gauss line or closer	All ferromagnetic construction materials except small amounts of steel reinforcing bar, normally not exceeding 11 kg/m^2 (2.5 lb/ft^2).
5 to 15 gauss	Presence or movement of ferromagnetic objects over 45 kg (100 lb), such as pushcarts, hand trucks, gas cylinders.
2 to 5 gauss	Presence or movement of ferromagnetic objects over 450 kg (1000 lb), such as small delivery trucks, automobiles, pallet movers, forklifts, and elevators.
1 to 2 gauss	Presence or movement of ferromagnetic objects over 34,000 kg (75,000 lb), such as trains, large trucks.

Magnetic Field	*Objects Affected by the Magnetic Field*
15 gauss line or closer	Cardiac pacemakers, ferromagnetic implants, and unrestrained ferromagnetic objects, such as tools, keys, electronic equipment, analog watches, magnetic data storage media, and credit cards.
5 to 15 gauss	Cardiac pacemakers and electronic equipment, such as shielded CRTs, computers, shielded image intensifiers, and shielded photomultiplier tubes.
2 to 5 gauss	Very sensitive electronic equipment, such as unshielded image intensifiers and photomultiplier tubes.
1 to 2 gauss	Extremely sensitive electronic equipment, such as linear accelerators, electron microscopes, and CRTs.

The CRT in color monitors needs to be degaussed in magnetic fields above 1 to 2 gauss. Above 5 gauss, color monitors may need additional shielding to prevent display distortion. Sun workstations and peripherals are also affected by the magnetic field; refer to Section 3.10, “Sun Workstation Preparation,” on page 34 for a discussion of magnetic field considerations.

Because the magnetic field exists both horizontally and vertically, the effect of the field on persons, electronic equipment, computers, and other objects located above and below the magnet must be considered. Pacemaker hazard and other signs warning that a magnetic field is present may be needed in the space on the next floor above the magnet and on the floor below the magnet. Figure 4 shows the typical elliptical profile of the vertical (axial) stray magnetic fields for the 400-, 500-, 600-, 750-, and 800-MHz magnet systems (drawing is not to scale). Refer to Section 5.2, “Stray Field Plots,” on page 44 for stray magnetic field values. Table 24 lists the distances from the magnetic field centerline to the floor.

Combining that data with the data in Table 23 allows you to determine how far the fields extend above your ceiling and below your floor.

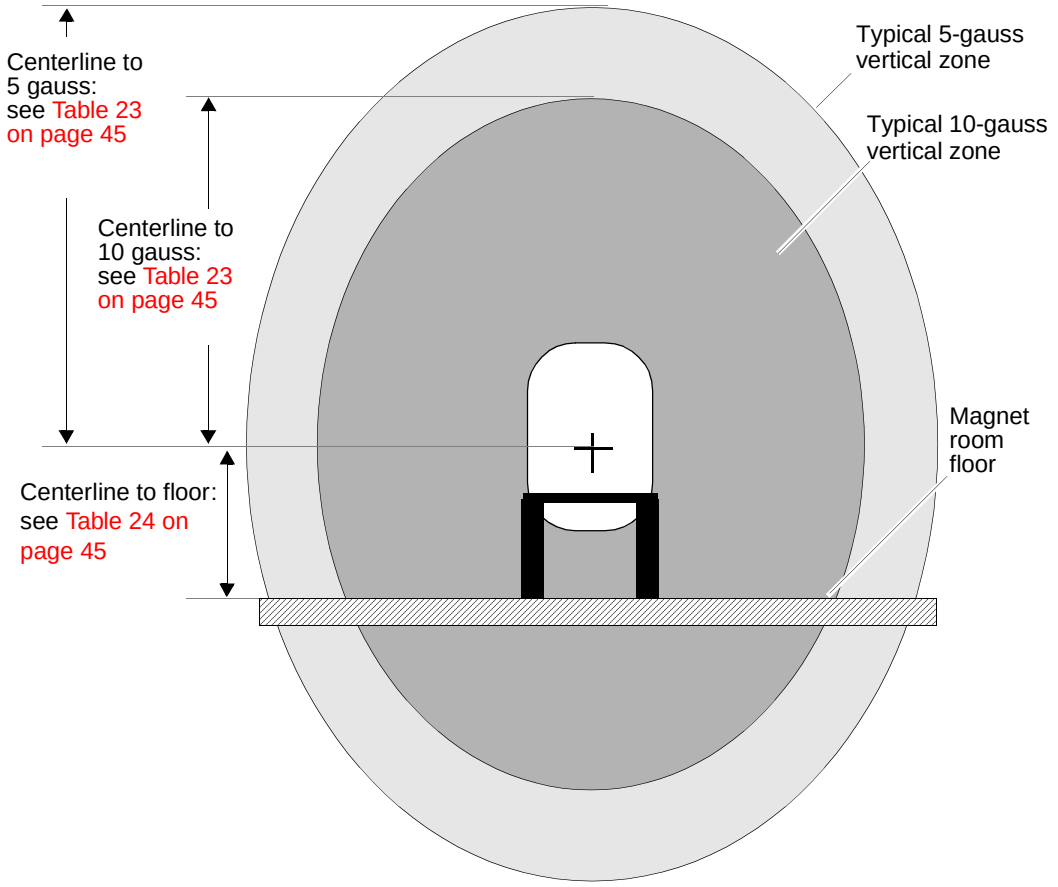

Centerline to 5 gauss: see Table 23 on page 45
Centerline to 10 gauss: see Table 23 on page 45
Centerline to floor: see Table 24 on page 45
Typical 5-gauss vertical zone
Typical 10-gauss vertical zone
Magnet room floor

Figure 4. Typical Vertical Stray Fields for High-Field Magnets

2.8 Radio-Frequency Interference In-Band

The site should be checked for radio-frequency interference (rfi) at or near the operating frequencies of the spectrometer, listed in Table 9, and most common nuclei, listed in Table 10). The level of any interference should be attenuated to an electrical field strength of less than 150 µV/m at the site of the magnet. Interference or cross talk often occurs when two spectrometers are located in the same room, referenced to the same power system, or operating at the same frequency.

Table 9. Operating Frequencies for NMR Spectrometers

Proton Frequency (MHz)	*Frequency Range (MHz)*
200	12 to 215
300	12 to 325
400	12 to 430
500	12 to 538
600	12 to 645
750	12 to 807
800	12 to 860

Table 10. Operating Frequencies for Common Nuclei

Nuclei	*4.6975 Tesla*	*7.0463 Tesla*	*9.3950 Tesla*	*11.744 Tesla*	*14.092 Tesla*	*17.616 Tesla*	*18.790 Tesla*
^{1}H	199.75	299.75	399.75	499.75	599.75	749.75	799.75
^{19}F	187.91	282.00	376.07	470.15	564.23	705.34	752.38
^{31}P	81.96	121.34	161.82	202.30	242.78	303.50	323.74
^{13}C	50.22	75.36	100.51	125.65	150.80	188.56	201.09
^{29}Si	39.68	59.55	79.41	99.28	119.14	149.98	158.87
^{2}H	30.66	46.01	61.36	76.71	92.06	115.09	122.77
^{15}N	20.24	30.37	40.51	50.64	60.77	76.97	81.04
^{39}K	9.32	13.99	18.65	23.32	27.99	34.99	37.32

2.9 Ventilation

Air ventilation must be adequate to displace the liquid helium gas during a quench. Gaseous helium or nitrogen exhausted from the magnet will displace oxygen and cause asphyxiation if not properly ventilated. During a magnet quench, the evaporated helium is exhausted from the manifold through the pressure relief valves. The amount of gas exhausted depends on the amount of liquid helium in the magnet at the time of the quench. Table 11 lists the approximate total amount of liquid helium possible for each magnet system, but it is unlikely that a magnet quench will boil off the total amount listed in Table 11. Also, remember that vented helium gas fills the room from the ceiling down, so place fans and ducts accordingly. Direct return vents leading to a local cold water air conditioning unit may ingest enough cold gas to result in freezing and possibly rupturing the chiller.

Table 11. Liquid Helium Displacement for Room Ventilation Considerations

Magnet/Bore (MHz/mm)	*LHe Maximum Volume (liters)*
200/89	76
300/89	76
400/89 AS	69
500/89 AS	130
600/89	115
800/63	450

The expansion ratio of liquid helium at room temperature is about 740:1, which means that one liter of liquid helium expands to about 740 liters of helium gas.

- For fans rated in LPM (liters per minute), multiply the LHe maximum volume listed in Table 11 by 740 to get an idea of helium gas the fan should be capable of displacing.
- For fans rated in CFM (cubic feet per minute), multiply the LHe maximum volume listed in Table 11 by 26.13 (includes expansion ratio) to get an idea of the total amount of helium gas that the fan should be capable of displacing (e.g., a magnet that holds 30 liters of LHe will require a fan that can displace about 784 ft^3 of helium gas).

2.10 Ambient Temperature and Humidity

Table 12 lists the required ambient temperature ranges, temperature stability, and humidity levels for the site. For optimal performance, the ambient temperature around the magnet should not vary. Magnet homogeneity is optimized if the ambient temperature stability is

maintained for the duration of an experiment and between shimming. Sunlight should never shine directly on the magnet or the area surrounding the magnet.

If necessary, install an air conditioning system to maintain the required conditions. Keep the air conditioning system operating continuously to stabilize the temperature and humidity surrounding the spectrometer system. The air flow from the room heating and cooling system must not blow on the magnet. Do not allow moisture to collect on, in, or around the system. At high altitudes (above 5000 ft), the cooling efficiency for the electronics is lower. This can be compensated for by lowering the room temperature by one or two degrees from the room temperature specification.

Table 12. Ambient Temperature and Relative Humidity

Mode	*Temperature* ° *C*	° *F*	*Relative Humidity Noncondensing*
Operational range	17 to 24	60 to 75	20% to 80%
Optimum	20	68	40% to 60%
Temperature stability	± 1.0	± 1.8	
Storage/shipping range	–20 to 60	–4 to 140	8% to 80%

2.11 Helium and Nitrogen Refill Volumes and Intervals

Table 13 lists typical refill volumes and intervals for helium and nitrogen. Locating a reliable local source of liquid helium and nitrogen is particularly important. Use the values listed in Table 13 when making arrangements for an on-going supply of liquid helium and liquid nitrogen. Note that refill volumes vary 20 to 40% depending on the refill efficiency and conditions.

Table 13. Helium and Nitrogen Refill Intervals and Volumes

Magnet/Bore (MHz/mm)	*Helium Refill Interval (days)*	*Helium Refill Volume (liters)*	*Nitrogen Refill Interval (days)*	*Nitrogen Refill Volume (liters)*
200/89 LH203	203	68	14	61
200/89 LH365	365	112	14	67
300/89 LH203	203	68	14	61
300/89 LH365	365	112	14	67
400/89	180	60	14	67
500/89	120	90	18	121
600/89	90	60	18	121
800/63 (2.2 K)	60	328	14	167

Chapter 3. Site Preparation

Sections in this chapter:

- 3.1 “Line Voltage Variation” this page
- 3.2 “Uninterrupted Power Supply” page 30
- 3.3 “Electrical Outlets” page 30
- 3.4 “Compressed Air Supply” page 31
- 3.5 “Switching Gas Supplies” page 32
- 3.6 “Compressed Nitrogen Gas” page 33
- 3.7 “AC Power and Air Conditioning” page 33
- 3.8 “Telephone and Internet Access” page 33
- 3.9 “Electrostatic Discharges” page 34
- 3.10 “Sun Workstation Preparation” page 34

Verify the configuration with a Varian, Inc. representative before designing the room layout. Site preparation must conform with federal, state, and local codes, which take precedence over recommendations in this guide. Approval by a building inspector might be necessary.

3.1 Line Voltage Variation

Infinity$_{plus}$ spectrometers require one line at 220 Vac (+10/–7%), single phase for the console, one for the accessory rack, and one for each power amplifier. The computer workstation requires either 120 Vac or 220 Vac. Current ratings are listed in Table 14.

Measure and record the ac line voltage for 48 hours using a suitable power line analyzer, such as the BMI Model 4800 or equivalent. Provide a copy for the Varian installation engineer. Requirements are the following:

- Long-term voltage variations (slow average) do not exceed 7% of nominal line tap voltages.
- Short-term voltage variations (sag or surge), with a duration between several milliseconds and several seconds, do not exceed 10% of nominal line tap voltage.
- Line transients (impulse), with a duration between 1 µs and 800 µs, do not exceed 50 V peak above or below nominal line tap voltage. These transients must be measured at the power plug with a load connected that draws the same power as the spectrometer.
- AC line frequency does not vary by more than +0.5 to –1.0 Hz.

Installing a line conditioner and regulator is strongly recommended. By providing protection against transients and improving line regulation, total system “up-time” improves and the electronic components within the system last longer. In many locations,

a good power conditioning system can pay for itself within a few years. Contact a local power consultant for suitable equipment in your area.

3.2 Uninterrupted Power Supply

If your site experiences frequent and short (less than 10 minutes) power outages, you should consider installing an uninterrupted power supply (UPS). UPS systems are limited in how long they can supply power when house power is out. Consider the placement of a UPS when planning your lab. If you want to use a single UPS, it must have output for 220 Vac and 120 Vac and it must be installed such that both the NMR console and the host workstation can use it. If the UPS does not provide a 220 Vac output, use a step-up transformer to boost the 208 Vac output to 220 Vac. You can purchase an autotransformer from Varian (Part No. 01-901886-00). Due to the large current draw, solids systems often require more than one UPS, which may also need an autotransformer.

To determine the power rating for the UPS (in kW), refer to Table 16 on page 33 and add the values (kW) for the accessories with your system.

3.3 Electrical Outlets

Table 14 lists the electrical outlets/circuits requirements of system components. The sections below details the requirements of each component. If you have the choice between two voltages in the range, it is generally better to choose the high voltage side since sites tend to suffer sags more than increases in voltage. The specification of 220 +10/-7% Vac means that you can operate at voltages as low as 204.6 Vac. That voltage is a minimum and not recommended, any sags in that voltage level may lead to problems. Table 14 contains information for how to improve the operating conditions when in this low voltage region. “Twistlok” style connectors are recommended to reduce the risk of accidentally disconnecting power during operation. Due to the large number of plug configurations world-wide, Varian does not ship end connectors on cords. Obtaining appropriate local connectors is the customers responsibility.

Table 14. Electrical Outlets/Circuits Requirements

Usable Cable Length	*Component*	*Required Outlets/ Circuits*	*Electrical Requirements (single phase at 50–60 Hz)*	*Operation in 190-205 Va Range(Asian Market)*
8 ft	Host workstation and peripherals	2	100 – 125 Vac, 15 A minimum or 220 - 240 Vac, 15 A	Ok
16 ft	*Infinityplus* two-cabinet console	1	220 +10/–7% Vac, 20 A	Step-up[1]
15 ft	CMA amplifier (each) ($^{1}H/^{19}F$)	1	220 +10/–7% Vac, 30 A	Step-up[1]
20 ft	AMT amplifier (each) (X or Y band)	1	220 +10/–7% Vac, 15 A	Jumper select
18 ft	*Infinityplus* accessory cabinet	1	90 – 132 Vac, 15 A 190 – 240 Vac, 15 A	Operate in lower voltage range

[1]The console and each proton/fluorine amplifier require a dedicated autotransformer (i.e. step-up transformer), see Section 3.2 on page 30.

Host Workstation and Peripherals – The host workstation and accessories require a minimum of two 120 Vac or one 220 Vac, single-phase power outlets. Varian, Inc. provides a power distribution strip with six outlets. If your location has ac voltages outside the specified voltage range in Table 14, you should check with your local Varian service center for power outlet requirements. Locations with ac voltages over 125 Vac might need at least one step-down transformer. To minimize ground loop interference, electrical outlets should all be on the same 20-A service. *Surge protection is strongly recommended.*

***Infinityplus* Two-Cabinet Console –** The standard two-cabinet console requires a dedicated single-phase, continuous-duty 220 Vac power line with 20-A minimum service (for up to 4 channels). Terminate this line within 3 m (10 ft) of the center of the standard two-cabinet console with a fused, quick-disconnect switch box or circuit breaker. It is usually best to have the power duct on the left, off to the side of the cabinet, unless there is enough room to leave the console about three feet from the wall. If there is room, center the power duct behind the console.

***Infinityplus* Amplifier Cabinets** – Each CMA amplifier in this cabinet requires 220 Vac single-phase, 30-A service. Each AMT amplifier requires 220 Vac single-phase, with 20-A service. It is best to have the power connection off to the side of the console unless there is about three feet of clearance behind the console. The power bay can be on either side of the console, but it is usually to the right as viewed from the front.

***Infinityplus* Accessory Cabinet –** One 220 Vac, single-phase, 15-A outlet for the accessory cabinet. The cabinet has its own distribution strip.

Other Accessories and Test Equipment – At least six outlets are needed within 1.8 m (6 ft) of the host workstation, standard cabinet, and magnet. The outlets must have ground connections and provide a minimum of 2.30 kVA at the local single-phase line voltage (120 Vac at 20 A, or 230 Vac at 10 A).

3.4 Compressed Air Supply

The house compressed air supply must provide a source of air that is clean, dry, and free of contaminants, with a dew point of –40°C (–40°F) minimum.

The delivery pipes should be at least 1/2-inch copper piping specified as *air handling lines*.

Install a ball valve on the permanent outlet of the air supply line. The ball valve must be rated at least 860 kPa (125 psi or 9 kg/cm^2), with an open diameter matched to the copper piping. If the house line pressure is greater than this level, the valve must be rated at a level that exceeds the house pressure. Attach to the valve a minimum 1 cm (0.5 in.) pipe terminated with a 1/2-inch male National Pipe Thread (NPT). The termination fitting should be within 6 m (20 ft) of the planned location of the accessory cabinet. A first stage air regulator, see Figure 5, capable of ±2 psi is also suggested upstream from the ball valve when 90 PSI, or greater, can be reached at the output.

In areas where humidity is high or where moisture in the air supply is a problem, consider installing a prefilter with an automatic drain to help prevent overload of the filter. In extreme cases, an air dryer assembly may be necessary.

The source should include a reservoir and be capable of delivering the air pressures (in kilopascals or pounds-per-square-inch-gauge) and flow rates (in liters-per-minute or standard cubic-feet-per-hour) after filtering as given in Table 15. Designing to the flow rates stated in Table 15 should allow for optimum life from your compressor and allow your delivery system to maintain a high quality of air. A coalescing filter and particulate filter

are required and must be supplied and installed by the customer. The particulate filter should be capable of filtering to 0.1 micron.

The installation engineer will install on your air termination fitting a Varian-supplied assembly that includes a 0 to 690 kPa (0 to 100 psi) pressure gauge and air lines to the appropriate accessories.

Table 15. Compressed Air Pressure for Nitrogen and Air

System Configuration	*Pressure at Device*	*Flow Rate**
System with optional antivibration systems	552 kPa (80 psig)	0.067 LPM (0.14 SCFH)
Infinityplus VT and purge	552 kPa (80 psig)	169 LPM (360 SCFH)
Infinityplus spinning	552 kPa (80 psig)	141 LPM (300 SCFH)

**Total source required is 600 SCFH minimum.*

3.5 Switching Gas Supplies

Varian, Inc. recommends using a three-way or diverting-ball valve to allow switching of gas sources. With this valve installed, each supply line will have a shut-off valve and regulator on the supply side of the switching valve. The first stage regulators can be omitted if the line pressure downstream of the regulator will be less than 90 PSI with the regulator in-line. As a general practice, both VT and spinning will run off of nitrogen gas or compressed air; the sources are not normally different for the two outputs. Varian, Inc. does not recommend using a quick -connect fitting to switch sources since they usually introduce a significant flow restriction. Varian, Inc. supplies a Tee fitting with adaptors to go from 1/2-inch NPT female fitting to the connections for the air management box and the MAS speed controller. A 3/8-inch hose barb fitting is included as an alternate input in the Tee in case the 1/2-inch NPT is not available. Refer to Figure 5.

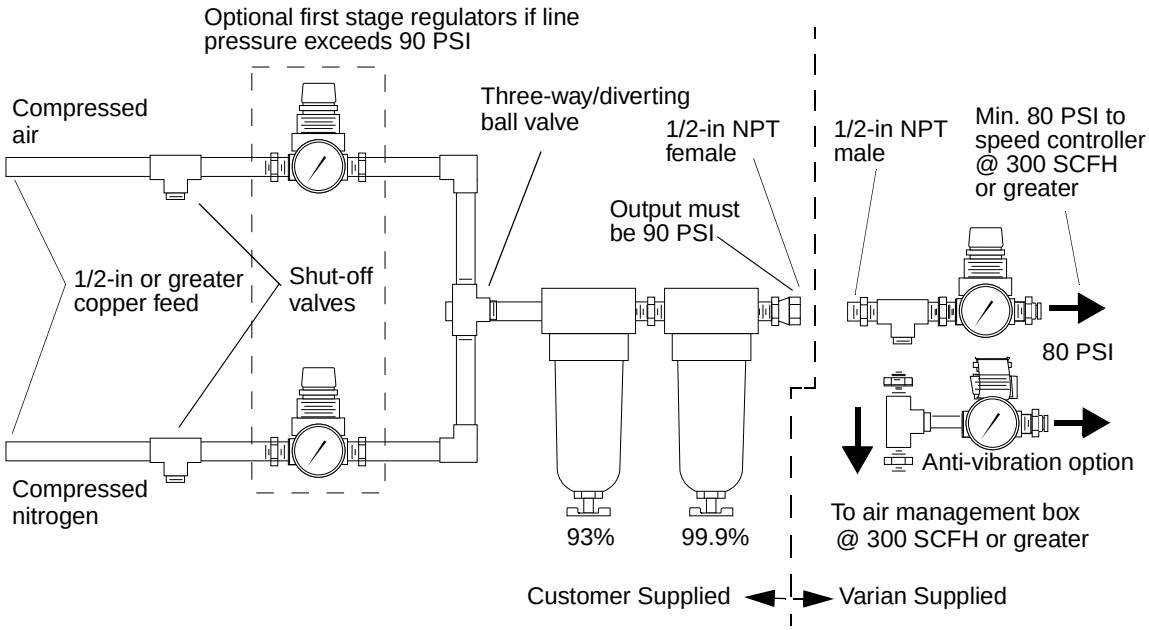


Figure 5. Setup for Switching Gas Supplies

3.6 Compressed Nitrogen Gas

During low temperature operation (below room temperature) of the variable temperature accessory, a compressed nitrogen gas supply (from a cylinder or a fixed line) is required that is dry, oil-free, and magnetically clean (e.g., free of rust), with a dew point of –193°C (80 K). The flow, pressure, and filtration rates through the regulators are the same as those listed for the compressed air supply.

It is acceptable to operate below room temperature using compressed air so long as the dew point is low enough to prevent condensation in the coldest part of the system, usually the cooling apparatus.

3.7 AC Power and Air Conditioning

Use Table 16 to help determine *maximum* surge current and air conditioning requirements.

A filter on the air conditioning unit intake and special air filtration is required in installations exposed to corrosive gases, salt air, or unusual dirt or dust conditions. The air conditioning system requires a power line separate from the spectrometer system.

Table 16. Maximum Air Conditioning Requirements

For standard systems and host workstations.

System	*Power (kW)*	*Surge Current*[1] *(A)*	*Heat output*[2] *BTU/hr*
Infinityplus two-cabinet console[3]	1.7	70	5800
Accessory cabinet	0.02	–	68
Computer and monitor[4]	0.24	22	824
Printer	0.057	19	200
AMT amplifiers (X or Y band)	1.2	23	4000
CMA (H band)	0.6	–	2050
Pulsed Field Gradient Amplifier	0.3	–	1025

1. Decay time <150 ms.

2. Conversion of the unit of heat energy between BTU and the amount of system power is calculated using
1 kWh = 3413 BTU.

3. Measurements are only for the standard acquisition and rf console, which does not share an ac power branch with the host workstation.

4. Measurements are only for the host workstation, which does not share an ac power branch with the acquisition and rf console.

3.8 Telephone and Internet Access

Varian, Inc. requires locating a voice telephone line near the host workstation. This telephone enables interactive troubleshooting between the customer and Varian support personnel.

Varian also strongly recommends that Internet access be provided during and after system installation. By providing external access to the spectrometer, technical problems can be

quickly analyzed by the engineering and scientific staff at Palo Alto. After the system is installed, applications-related questions can be answered in real time by Varian's NMR applications people. As a matter of policy, Varian provides online support during installation and during the warranty period. If direct access to the Internet is not technically feasible, a high-quality analog telephone line can be used.

If internal security policies preclude ready modem or Internet access to the spectrometer, contact Varian's installation department for a list of options that might satisfy security concerns.

3.9 Electrostatic Discharges

Electrostatic discharges less than 15 kV generally do not result in any perceivable errors or problems. Discharges greater than 15 kV, however, might result in loss of data and errors perceivable to the operator. Discharges greater 25 kV can cause damage to the equipment.

To prevent electrostatic discharge damage, the system should be installed on vinyl-covered floors and be properly grounded. If carpeting is installed, the carpet should contain only a small percentage of nylon and be installed over antistatic pads. Alternatively, regular use of a good quality antistatic spray can help considerably in alleviating the problem. Whenever a printed circuit board must be touched or handled, the person should wear grounded wrist straps.

CAUTION: **Many components in the system contain highly sensitive electronic devices that must be protected from electrostatic discharges by proper floor coverings and grounding practices. A person walking across a nylon carpet or wearing synthetic fabrics can generate an electrostatic charge that can discharge to the next object that is touched. If this happens to be the system, the system components can be damaged. An overly dry atmosphere also tends to create an electrostatic charge. As with any system based on integrated circuits, the system is susceptible to static spikes, both those generated on the power line and those generated in the lab area, that must be suppressed.**

3.10 Sun Workstation Preparation

Varian NMR spectrometers are operated using a Sun workstation as a host computer. Regardless of whether the Sun was purchased from Varian or separately, certain preparations are required. Some of these preparations have been outlined previously in the section "Electrical Outlets" on page 30. The following sections contain additional considerations.

Magnetic Field Considerations

The spectrometer host workstation system and magnetic storage media (hard disk, streaming magnetic tape cartridge, etc.) must be located at a sufficient distance from the magnet such that the magnetic field cannot damage the data. For a Sun workstation, this specification is less than 5 gauss. The distances at which this gauss level is present are different for each kind of magnet and must be taken into account when planning the room size. See the field plots in Section 5.2, "Stray Field Plots," on page 44 for typical distances

at which various gauss levels exist for particular magnets, but be aware that these distances vary somewhat for each magnet and should be checked after a magnet is installed.

Sun Workstations

Infinityplus spectrometers require a Sun host computer that meets the requirements listed in Table 17.

Table 17. Host Computer Requirements

Item	*Requirement*
Host computer	Sun Ultra 5 or better
Solaris version	Solaris 2.6 or later
RAM	64 MB minimum; 128 MB preferred
Hard disk	9 GB preferred (4 GB minimum)
Graphics	8- or 24-bit color
Peripherals	CD-ROM drive is required Tape backup device recommended

The host workstations must have at least 64 megabytes (MB) of RAM, but 128 MB is recommended (CDE requires 24 MB of RAM). Solaris and Spinsight require a minimum total hard disk space of 3 GB.

Monitors can be any size. Graphics can be “plain” or the GX version (the GX series provides higher performance). Base level graphics work fine with Spinsight. Higher performance graphics configurations (e.g., Creator Elite) are also compatible with Spinsight. Either 8-bit or 24-bit graphics are supported.

Sun Peripherals

A CD-ROM drive is required to load the Solaris and Spinsight software onto the host workstation. The CD-ROM drive might not automatically be included with a Sun workstation; it is included when the Sun computer is part of a NMR spectrometer purchase. While loading the software remotely is possible, loading the software locally is preferred. Often, the remote computer is password protected and thus requires the presence of the system administrator to enter the password and grant access. Should any troubleshooting or software reloads be required, the process would be complicated by the need for the system administrator.

A back up device, such as a tape drive, is strongly recommended.

Solaris Media

Sun workstations, whether purchased from Varian or another source, include the UNIX “right-to-use” license. If you purchase a Sun workstation through Varian, a current version of Solaris on a CD-ROM is included. If you purchase the Sun workstation from another source, you must purchase a copy of the Solaris CD-ROM or make sure a copy is available. At least one copy of the CD-ROM available for the installation is *required*.

Note that the Varian-supplied media might not be for the latest version of Solaris. It is, however, the latest supported by Varian. In case of doubt, please contact Varian.

Solaris Installation

All Sun computers for use with an *Infinityplus* system are configured at the Fort Collins factory. If you have directly purchased the Sun computer from a source other than Varian,

Inc., the computer must be shipped to the Fort Collins factory to be properly loaded with software.

Preinstalled Solaris cannot be used with Spinsight and *Infinityplus*.

Sun Documentation

Solaris contains extensive online documentation. For these reasons, full Sun UNIX documentation is *not* included with the purchase of a Sun workstation (whether from Varian or another source).

Full Solaris documentation is available at:

`http://docs.sun.com/`

Full hardcopy documentation *is* available from Sun through SunExpress, but such documentation is not required for installation or use of the system.

Sun Workstation Preparation Checklist

_____ Sun workstation is an Ultra or SPARCstation capable of running Solaris 2.6 or newer.

_____ Hard disk space is 4 GB or larger. RAM is 64 MB or more.

_____ CD-ROM drive is installed locally or readily accessible on a networked computer.

_____ Solaris CD-ROM is available.

If you have purchased the Sun workstation from a source other than Varian:

_____ Sun workstation shipped to Fort Collins factory for proper configuration.

_____ Sun workstation and peripherals installed and configured according to Varian specifications.

Configuration and Peripherals

Printers should be parallel (Centronics) and must be capable of accepting PostScript. Sufficient RAM for a full page of PostScript is required. this might be more than the minimum supplied, depending on the plotter and paper size.

X server software must be capable of supporting RSH, REXEC, XDM, or XDMCP.

Collecting System and Network Information

The Solaris installation program prompts you to enter some system and network information before installation begins. You can save time by collecting this information now, before booting from the Solaris CD-ROM.

Use the Table 18 to record your system information. Each field on the worksheet is described below.

If your system is not connected to a network, you need to know or create only the Host name, root password, and the time zone. If your system is on a network, you need additional information described in the following sections. If unsure, contact your network administrator.

System Configuration Type

You are asked to configure your Sun workstation as one of the following: server, standalone, or dataless client. A *server* is a system that provides network services such as

file transfer and storage space. A *standalone* system is a system that contains its own hard disk and bootup files. A *dataless client*, sometimes called diskless client, is a system without its own hard disk and uses an NFS server for the operating system, storage, and other services. For the purposes of Spinsight, you must install your system as a standalone system.

Selecting a Host Name

Each computer on a network has a *host name* that uniquely identifies the computer. If you already have a version of UNIX installed, you can use the command `uname -n` from within a shell to display this information for a Sun workstation.

When choosing a host name, make sure the name you select is unique within both your local area network and, if applicable, your name service domain.

In many networks, the choice of a host name is left up to the owner of the Sun workstation (subject to the requirement of uniqueness). A host name can be up to 64 uppercase or lowercase characters. It is strongly recommended that you use all lowercase characters in the host name because some networking software that might be used in other computers on the network could require lowercase host names. Choose a name that starts with a lowercase letter, followed by any combination of lowercase letters, numbers, or hyphens. The name, however, cannot end with a hyphen.

Table 18. Preinstallation Worksheet for Solaris

Category	*Your Configuration*
Host Name Example: *`mysystem`* If VNMR is to be installed as well as Spinsight, do not use: `inova`, `inovaauto`, `gemcon`, or `wormhole`	
Primary Network Interface Use: `le0` for 10baseT Ethernet boards; or `hme0` for Ultras or 10/100baseT Ethernet boards.	
IP Address Use: *`192.9.200.1`* for non-networked spectrometers, or your network IP number for all other networked systems.	
Name Service Choose *NIS* (not *NIS+*)	Choose *NIS*
Domain Name Example: *`our.domain`*	
Name Server Host Name Example: *`ourserver`*	
Name Server IP Address Example: *`195.5.2.25`*	
Subnet Mask Example: *`255.255.255.0`*	
Time Zone Examples: *US/Mountain*, *US/Pacific*, *US/Eastern*	
System Configuration Type Choices: *Server*, *Standalone*, or *Dataless Client*	Choose *standalone*
Disk Layout *Disk layout sizes vary according to disk size.*	

Obtaining the IP Address

Your Sun workstation must have a unique Internet Protocol (IP) network address if your Sun workstation is to be attached to a network. Consult your network administrator about the address. If the software is being installed on a Sun workstation that is already connected to a network, the command `ypcat hosts | grep `uname -n`` can be used to display the IP address of your Sun workstation. Note the use of back quotes (`) in this command.

If NIS is not enabled, use the command: `cat /etc/hosts | grep uname -n`

Selecting a Subnet Mask

The subnet mask is a number that is used to split IP addresses into the network (Internet) and host parts. If your site does not use multiple subnets, use the default number; otherwise, consult your network administrator. For a Sun workstation connected to a network, the command `cat /etc/netmasks` can be used.

Selecting the Name Service Type

The name service prompt allows choosing between NIS, NIS+, and none. Choose NIS (not NIS+). You will need to enter the host name and the IP address of the computer from which you receive the service. If you choose none, you are not prompted for additional information. Ask your network administrator what name service the network uses.

Entering the host Name and IP Address of the Name Server

With NIS as the name service type, it is assumed that there is another computer on the network that is the current NIS server. You are asked to enter the host name and IP address of the server that provides the name service. On an existing computer, the server's name can be displayed by entering the command `ypwhich`. The server's IP address and other information can be displayed by entering the command `ypcat hosts | grep `ypwhich``. Again, note the use of back quotes (`).

Domain Name

The domain name is the name assigned to a group of computers that are administered together. All computers in the group (domain) are accessed by the same NIS or NIS+ maps. Your network administrator should be able to provide the domain name. You can also find your domain name by entering the command `domainname`.

Setting the Time Zone

Solaris software uses world time zones and automatically adjusts for daylight-savings time if appropriate. Time zones are specified by name, such as "US/Central."

Disk Layout

Your Sun workstation must contain at least one hard disk drive.

Chapter 4. Installation Supplies

Sections in this chapter:

- 4.1 “Required Installation Supplies and Equipment” this page
- 4.2 “Recommended Laboratory Supplies and Equipment” page 42

Certain supplies not provided by Varian, such as helium and nitrogen supplies, must be obtained by the customer *before* the Varian installation engineer can start the installation.

4.1 Required Installation Supplies and Equipment

The installation engineer will need the following non-Varian supplies and equipment during installation:

- Liquid helium supply
- Liquid nitrogen supply
- Helium gas supply
- Nitrogen gas supply
- Face mask and thermal gloves
- Heat gun
- Nonferromagnetic ladder
- Hoist
- Isopropyl alcohol and acetone

Locating a reliable local source of liquid helium and nitrogen is particularly important. As soon as possible after ordering a system, make arrangements for an initial delivery and an ongoing supply of liquid helium and nitrogen.

CAUTION: **Specify that supply dewars be made of nonmagnetic materials. A magnetic supply dewar next to the magnet can damage the magnet solenoid. A magnetic supply dewar can also be pulled into the magnet, possibly damaging the magnet or causing the magnet to quench.**

Liquid Helium Supply

To prevent unnecessary loss of the supply, request delivery just prior to the scheduled visit of the Varian installation engineer. Table 19 lists the amount of liquid helium (LHe) recommended at installation.

The amount of loss due to boiloff as the magnet is cooled varies. An initial LHe supply about 50% more than the amount expected to be necessary for cooling down the magnet is usually adequate; however, an additional supply for delivery on short notice is also advisable should the initial amount be insufficient. Table 19 shows the quantities recommended.

Table 19. Initial Onsite and Short Notice Liquid Helium Supplies

Magnet/Bore (MHz/mm)	*Initial Supply (liters)*	*Short Notice Supply (liters)*
200/89	300	200
300/89	300	200
400/89	300	300
400/89 AS	300	300
500/89 AS	1000	600
600/89	1000	600
800/63 (2.2 K)	3000	1000

Liquid Nitrogen Supply

Table 20 lists the recommended amount of liquid nitrogen (LN). LN storage containers suffer a loss of contents from boiloff, so request delivery of the supply just prior to the scheduled visit of the installation engineer. Provide an adaptor for connecting 9 mm (3/8 in.) ID rubber tubing to the LN container.

For low-temperature operation using the variable temperature accessory, a refrigerant is required. Most commonly, this is liquid nitrogen in the VT cooling bucket or the optional Kadel long run time liquid nitrogen dewar.

Table 20. Initial Onsite Liquid Nitrogen Supply

Magnet Field (MHz)	*Initial Supply (liters)*
200/89	325
300/89	325
400/89	325
400/89 AS	325
500/89 AS	700
600/89	700
800/63 (2.2 K)	2000

Helium Gas Supply

Table 21 lists the recommended number of helium gas cylinders. A regulator must be provided. Each cylinder should hold at least 8000 liters (285 ft^3). The helium gas must be the highest purity available: no less than 99.995% or U.S. Bureau of Mines Grade A. A *magnetic* helium gas container can be used provided the unit remains outside the 5 gauss limit of the magnet and the cylinder is firmly secured to avoid movement caused by the magnetic field.

Nitrogen Gas Supply for Magnet Installation

During installation, one cylinder of nitrogen gas is required for precooling the magnet and for transfer of liquid nitrogen. A regulator must be provided. A *magnetic* nitrogen gas container can be used if it is outside the magnet 5 gauss limit and the cylinder is firmly secured to prevent attraction to the magnet.

If the system is equipped with the variable temperature accessory, a nitrogen gas supply is required. The gas must be dry and chemically pure with a flow rate through the pressure of 19 LPM (40 SCFH) at 207 kPa (30 psig). For low-temperature operation, use prepurified grade gas (99.99%).

Table 21. Helium Gas Supply

Magnet field (MHz)	*Helium gas (cylinders)*
200/89	2
300/89	2
400/89	2
400/8 AS	2
500/89 AS	3
600/89	3
800/63 (2.2 K)	5

CAUTION: **To avoid movement caused by magnetic field attraction, helium gas and nitrogen gas cylinders made of *magnetic* material must be kept outside the 5-gauss limit of the magnet and firmly secured.**

Face Mask and Thermal Gloves

If cryogenic helium or nitrogen contacts living tissue, a serious injury (similar to a burn) can occur. Order appropriate safety coverings for use during dewar servicing, including a mask that protects the face completely and a loose-fitting pair of thermal gloves.

WARNING: **Avoid helium or liquid nitrogen contact with any part of the body. If liquid helium or nitrogen contact living tissue, a *serious injury* (similar to a burn) can occur. Never place any part of your body directly over the helium and nitrogen exit tubes on top of the magnet. If helium or nitrogen contacts the body, seek medical attention, especially if the skin is blistered or the eyes are affected.**

Heat Gun

Acquire a 1600 W heat gun (Dayton Model 27046 or equivalent) and heavy-duty extension cord for thawing ice accumulation and drying out moisture on dewar servicing equipment.

CAUTION: **These heat guns contain ferrous magnetic materials.**

Nonferromagnetic Ladder

Acquire a 180 cm (6 ft) nonferromagnetic ladder for reaching the top of the dewar while inserting and removing the helium transfer tube. The ladder should be sturdy and self-supporting with rubber feet. A somewhat taller 250 to 300 cm (8 to 10 ft) ladder is recommended for 800-MHz magnets.

Hoist

Consult Varian Installations to determine if Varian will provide a hoist. A hoist must be available to remove the magnet from the crate, assemble it, and move it into place. The capacity of the hoist depends on the weight of the magnet being installed. Table 5 on page 20 specifies magnet weights. Allow a safety factor of at least 100% above the weight

shown. Be sure adequate space is available for bringing the hoist and magnet in through the lab door.

WARNING: **Death or serious injury may result if the magnet is lifted with improperly assembled or improperly rated equipment.**

The hoist can be a chain hoist suspended from a moveable mechanism, such as an A-frame, or it can be permanently fixed above the area designated for the magnet, such as a beam. A vertical lifting device is required for magnets with anti-vibration legs; this vertical lifting device would eliminate the need for a “cherry picker” type device. Consult your plant facilities department or authorized Varian representative to ensure that adequate facilities are available.

Isopropyl Alcohol and Acetone Solvents

Obtain 1 pint (500 $cm^{3)}$ each of isopropyl alcohol and acetone. These solvents are needed to clean the magnet parts before assembly. Acetone should never be used for general cleaning as it can damage some plastics and paints.

4.2 Recommended Laboratory Supplies and Equipment

In addition to the required installation supplies and equipment, the following items are recommended:

- Cryogenic equipment rack
- Electrical power surge protector
- Monitor degaussing coil

Cryogenic Equipment Rack

Various items are used around the magnet for routine maintenance and handling, including a helium transfer tube, a flutter tube, Tygon tubing, and stingers. To protect the cryogenic equipment from damage and to keep it conveniently available, provide a rack to hold the items. A 1.2 m × 2.4 m (4 ft × 8 ft) peg board hung on a laboratory wall, with wood or plastic pegs, works very well.

Electrical Power Surge Protector

To protect the delicate electrical components of the Sun workstation (monitor, disk drive unit, CPU base, etc.), a good quality surge protector should be inserted in the power circuit serving the components. A single surge protector with six outlets should suffice if the components are located relatively close to one another. Contact an electronic professional for advice on quality surge protection in your area. If a UPS is to be used for line conditioning, a surge protector is unnecessary (See Chapter 3.3, “Electrical Outlets,” on page 30 for power ratings).

Monitor Degaussing Coil

The workstation monitor can gradually become somewhat magnetized due to its proximity to the magnet. This condition can be corrected with a degaussing coil. If the host workstation system is to be located near the edge of the 1–2 gauss stray field of the magnet, the degaussing coil is a necessity. For example, GC Electronics model 9317 (1801 Morgan St., Rockford IL., 61102, (815) 968-9661).

Chapter 5. Stray Magnetic Fields

Sections in this chapter:

- 5.1 “Safety Hazards of Strong Magnetic Fields” this page
- 5.2 “Stray Field Plots” page 44
- 5.3 “Posting Requirements for Magnetic Field Warning Signs” page 51

The magnetic field is typically the biggest concern when planning for an NMR system. This chapter contains magnetic field safety information and stray field plots.

5.1 Safety Hazards of Strong Magnetic Fields

The potential safety hazards of strong magnetic fields for devices such as certain pacemakers must be understood and planned for. A set of plots indicating the magnitude of the stray fields for each type of magnet is included in Section 5.2, “Stray Field Plots,” on page 44. These plots show typical levels of stray field. Actual levels may vary and should be checked after a particular magnet has been installed.

WARNING: **Cardiac pacemaker wearers *must* remain outside the 5-gauss perimeter from the magnet until safety is clearly established. An NMR superconducting magnet generates strong magnetic and electromagnetic fields that can inhibit operation of some cardiac pacemakers, which could result in death or serious injury to the user. Consult the pacemaker user’s manual, contact the manufacturer, or confer with a physician to determine the effect on a specific pacemaker. Varian provides signs with each system to warn pacemaker wearers of this hazard. Post the signs according to Section 5.3, “Posting Requirements for Magnetic Field Warning Signs,” on page 51.**

Pacemakers

Cardiac pacemaker wearers must not enter a zone that would subject a cardiac pacemaker to a magnetic intensity that could cause adverse effects. In many instances, this zone includes space on the floors directly above and/or below the magnet. For assistance in determining the effect of a system on pacemaker, consult the pacemaker user’s manual, contact the pacemaker manufacturer, or confer with a physician to determine the effect on a specific pacemaker. Actual levels vary and should be checked after a particular magnet has been installed.

Magnetic Field Exposure

NMR workers are often exposed to high levels of static magnetic fields. At this time, no conclusive scientific evidence exists indicating adverse health effects at current exposure levels. Current exposure levels are generally indicated as levels equal to or less than those in Table 22.

Although some studies suggest a link between magnetic field exposure and adverse reproductive effects, the body of medical data available is not clear enough to draw any firm conclusions regarding risks to pregnancy. Static magnetic field associated with the NMR spectrometer magnets are not considered by the scientific community at this time to comprise a risk to pregnancy or a reproductive hazard.

An article by the American Conference of Governmental Industrial Hygienists (ACGIH) entitled "Threshold Limit Values and Biological Exposure Indices, 5th ed." states the following:

> "TLVs [Threshold Limit Values] refer to static magnetic flux densities to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. These values should be used as guides in the control of exposure to static magnetic fields and should not be regarded as a fine line between safe and dangerous levels.
>
> "Routine occupational exposures should not exceed 60 milliteslas (mT)—equivalent to 600 gauss—whole body or 600 mT (6000 gauss) to the extremities on a daily [8 hour], time-weighted average basis. A flux density of 2 teslas (20,000 gauss) is recommended as a ceiling value."

Table 22. Stray Field Data for Oxford Magnets at ACGIH Exposure Values

Magnet Type	*Radial Distance (cm)*			*Axial Distance (cm)*				
(MHz/mm)	*0.6 kG*	*6 kG*	*20 kG*	*0.6 kG*	*6 kG*	*20 kG*	*Base to CL (cm)*	*Magnet Outside to CL (cm)*
800/63 (2.2K)	129	52	24	171	84	59	57.6 ±0.3	58.4
600/89	75	*15*	*14*	105	55	41	46.6	36.2
500/89 AS	a	*a*	*a*	74	44	b	39.1	46.0
400/89 AS	a	*a*	*a*	63	37	*b*	36.3	36.2
300/89	40	*a*	*a*	59	*b*	*b*	35.7	36.2
200/89	*a*	*a*	*a*	56	*b*	*b*	35.1	36.2

a. Where no radial position is given, the point is within the cryostat body.
b. The axial point is in the cryostat bore. Compare with the magnet centerline (CL) distance.

5.2 Stray Field Plots

This appendix shows typical stray field data and plots for each magnet. The values are typical but may vary between individual magnets. Gauss levels should be checked after a particular magnet has been installed. The values in Table 23 were provided by Oxford technical documentation. Table 24 lists the distance from the magnet centerline to the floor for high-field magnets.

Table 23. Stray Field Data for NMR Magnet Systems

Magnet Systems		*Axial Distance from Magnet Center Line*				*Radial Distance from Magnet Center Line*			
(MHz/mm)	*(Tesla)*	*gauss (m)*				*gauss (m)*			
		1	*5*	*10*	*25*	*1*	*5*	*10*	*25*
200/89	4.69	4.6	2.65	2.05	1.49	3.50	2.00	1.60	1.15
300/89	7.04	4.7	2.75	2.20	1.63	3.75	2.20	1.75	1.26
400/89 AS	9.39	2.9	1.8	1.5	1.17	2.30	1.3	0.80	0.74
400/89	9.39	6.5	3.80	3.00	2.21	5.15	3.05	2.40	1.74
500/89 AS	11.74	4.0	2.5	1.90	1.45	3.10	1.75	1.40	0.96
600/89	14.09	8.55	5.00	3.97	2.92	6.75	3.95	3.14	2.32
800/63 (2.2K)	18.81	13.00	7.60	6.0	4.41	10.25	6.0	4.75	3.51

Table 24. Magnet Centerline to Floor

Magnet Systems (MHz/mm)	*Distance From Magnet Centerline to Floor (m)*
200/89	1.12
300/89	1.12
400/89,400/89 AS	1.13
500/89 AS	1.15
600/89	1.23
800/63	1.44

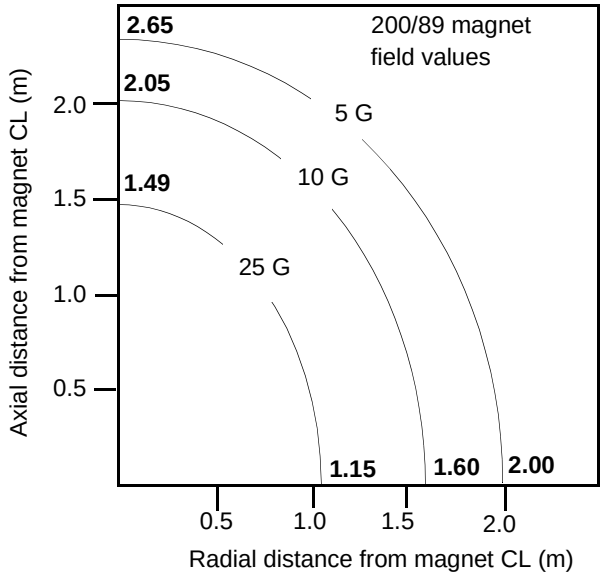


Figure 6. Stray Field Plots for 200/89 Magnets

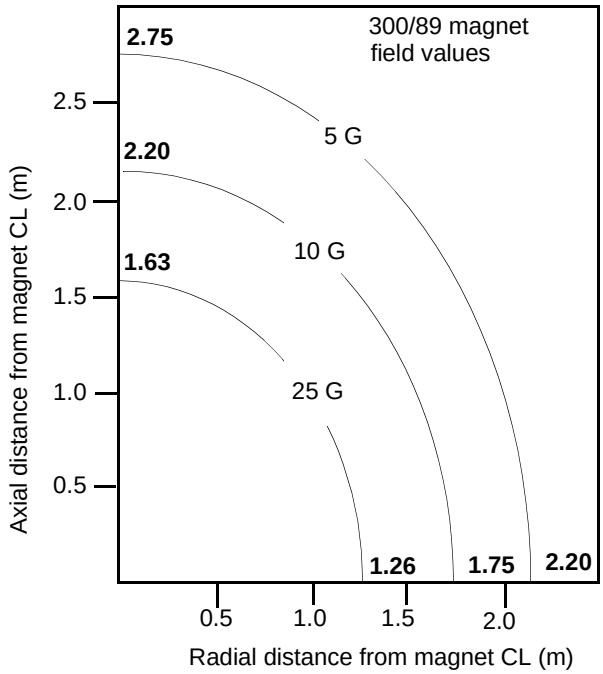


Figure 7. Stray Field Plots for 300/89 Magnets

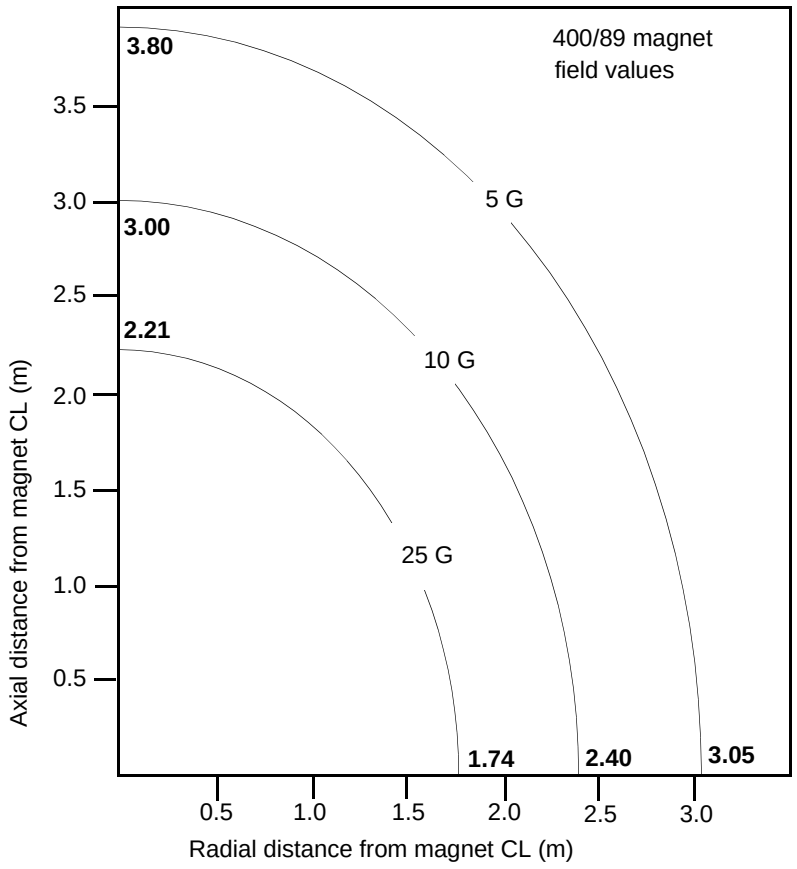


Figure 8. Stray Field Plots for 400/89 Magnets

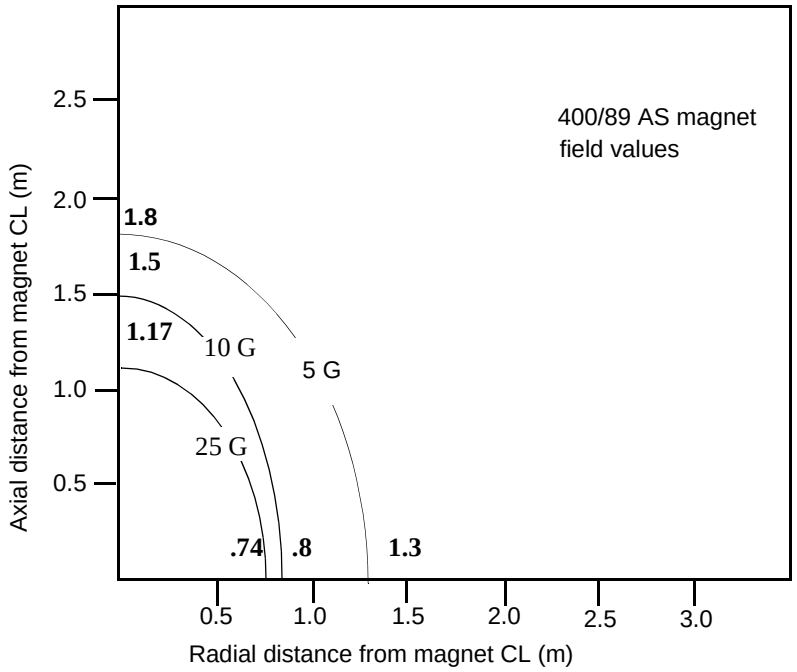


Figure 9. Stray Field Plots for 400/89 AS Magnets

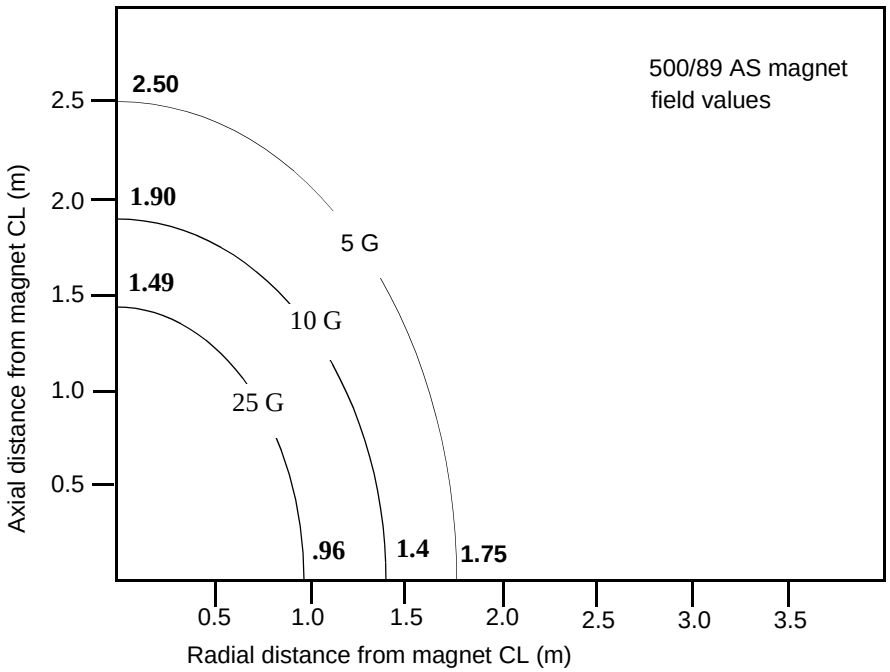


Figure 10. Stray Field Plots for 500/89 AS Magnets

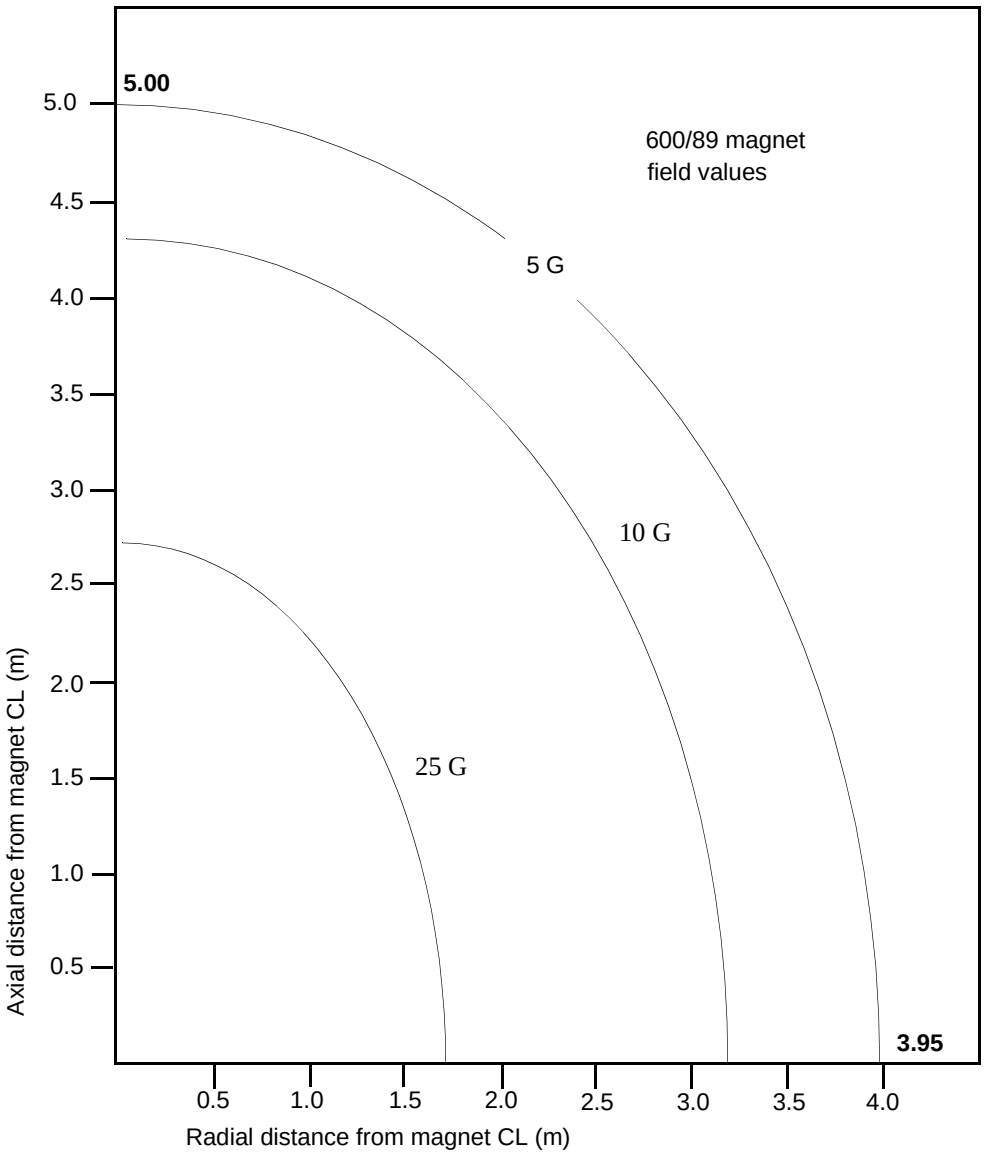


Figure 11. Stray Field Plots for 600/89 Magnets

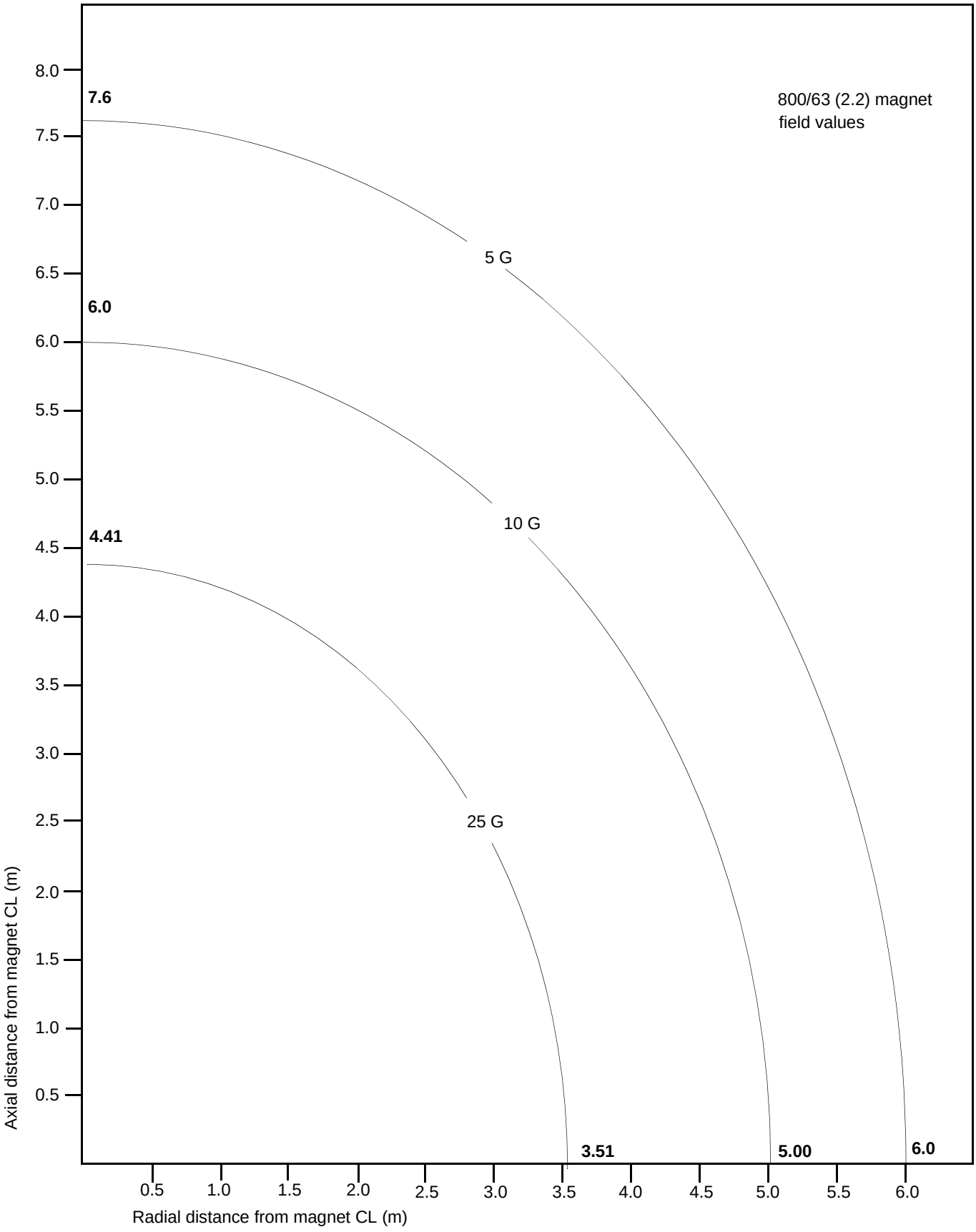


Figure 12. Stray Field Plots for 800/63 (2.2K) Magnets

5.3 Posting Requirements for Magnetic Field Warning Signs

The strong magnetic fields that surround a superconducting magnet are capable of causing death or serious injury to individuals with implanted or attached medical devices such as pacemakers or prosthetic parts. Such fields can also suddenly pull nearby magnetic tools, equipment, and dewars into the magnet body with considerable force, which could cause personal injury or serious damage. Moreover, strong magnetic fields can erase magnetic media such as tapes and floppy disks, disable the information stored on the magnetic strip of automated teller machine (ATM) and credit cards, and damage some watches.

To warn of the presence and hazard of strong magnetic fields, the customer is responsible for posting clearly visible signs warning of magnetic field hazards. This responsibility includes measuring stray fields with a gaussmeter.

Radio-frequency emissions may also pose a danger to some individuals. The rf emission levels from Varian NMR equipment have been measured and compared to the IEEE/ANSI C95.1-1991 standard. For further information, refer to the *RF Environment* section of the *Installation Planning Guide*.

Warning Signs

Varian provides signs to help customers meet this posting responsibility. These signs *must* be posted according to the following requirements *before the magnet is energized*:

1. *10-gauss warning signs* (Figure 13) – Post along the 10-gauss perimeter of the magnet so that a sign can be easily seen by any person about to enter the 10-gauss field from any direction. Refer to the manuals supplied with the magnet for the size of a typical 10-gauss stray field. Check this gauss level after the magnet is installed.

   Note that the stray field may extend vertically to adjacent floors, and additional signs may be needed there. A sign is not required if the 10-gauss field extends less than 30 cm (12 in.) beyond a permanent wall or less than 61 cm (24 in.) beyond the floor above the magnet.

2. *5-gauss warning signs* (Figure 14) – Post along the 5-gauss perimeter of the magnet so that a sign can be easily seen by any person about to enter the 5-gauss field from any direction. Refer to the manuals supplied with the magnet for the size of a typical 5-gauss stray field. Check this gauss level after the magnet is installed. Note that the stray field may extend vertically to adjacent floors, and additional signs may be needed there.

3. *Magnet area danger signs* (Figure 15) – Post at each entrance to the magnet area. Be sure each sign is outside the 5-gauss perimeter.

10-GAUSS WARNING
STRONG MAGNETIC FIELD
Tools and Equipment
Strong magnetic fields are present that can make magnetic items suddenly fly towards the magnet, which could cause personal injury or serious damage. Do not take tools, equipment, or personal items containing steel, iron, or other magnetic materials closer to the magnet than this sign.
Dewars
The stray field of the magnet can pull a magnetic dewar into the magnet body, causing serious damage. Use only nonmagnetic stainless steel dewars. Do not use iron or steel dewars during servicing.
varian

Figure 13. 10-Gauss Warning Sign

5-GAUSS WARNING
STRONG MAGNETIC FIELD
Pacemaker, Metallic Implant Hazard
Strong magnetic and rf fields are present that can cause serious injury or death to persons with implanted or attached medical devices, such as pacemakers and prosthetic parts. Such persons must not go closer to the magnet than this sign until safety at a closer distance is identified by a physician or device manufacturer.
Magnetic Media, ATM/Credit Cards
Strong magnetic fields are present that can erase magnetic media, disable ATM and credit cards, and damage some watches. Do not take such objects closer to the magnet than this sign.
varian

Figure 14. 5-Gauss Warning Sign

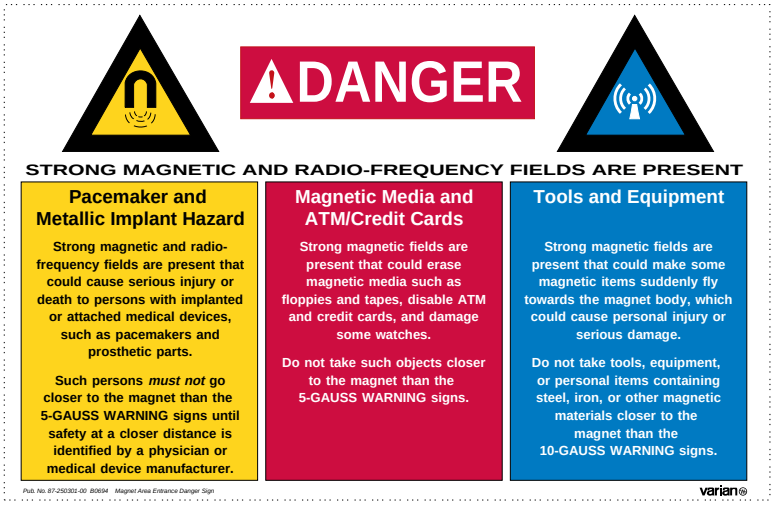

DANGER
STRONG MAGNETIC AND RADIO-FREQUENCY FIELDS ARE PRESENT
Pacemaker and Metallic Implant Hazard
Strong magnetic and radio-frequency fields are present that could cause serious injury or death to persons with implanted or attached medical devices, such as pacemakers and prosthetic parts.
Such persons must not go closer to the magnet than the 5-GAUSS WARNING signs until safety at a closer distance is identified by a physician or medical device manufacturer.
Magnetic Media and ATM/Credit Cards
Strong magnetic fields are present that could erase magnetic media such as floppies and tapes, disable ATM and credit cards, and damage some watches.
Do not take such objects closer to the magnet than the 5-GAUSS WARNING signs.
Tools and Equipment
Strong magnetic fields are present that could make some magnetic items suddenly fly towards the magnet body, which could cause personal injury or serious damage.
Do not take tools, equipment, or personal items containing steel, iron, or other magnetic materials closer to the magnet than the 10-GAUSS WARNING signs.
varian

Figure 15. Magnet Area Danger Sign

Stray magnetic fields can reach beyond the published distances when two or more magnetic fields intersect or when the field extends over large ferromagnetic masses or structures (steel doors, steel construction beams, etc.). In this case, the customer *must* measure the stray field using a gaussmeter to determine how the 5- and 10-gauss fields are altered (contact a scientific instrumentation supplier for information on acquiring a gaussmeter).

You can request additional signs from Varian by telephoning 1-800-356-4437 in the United States or by contacting your local Varian office in other countries.

For a list of Varian offices, see"Contacting Varian" on page 12.

Chapter 6. Room Layouts

This section provides some suggested NMR room layouts. The illustrations in this section are drawn approximately to scale. When designing room layouts, be sure to account for horizontal (radial) stray fields that can extend beyond the walls and vertical (axial) stray fields that can extend above the ceiling and below the floor. Refer to Section 5.2, “Stray Field Plots,” on page 44 for actual stray field plots for your magnet.

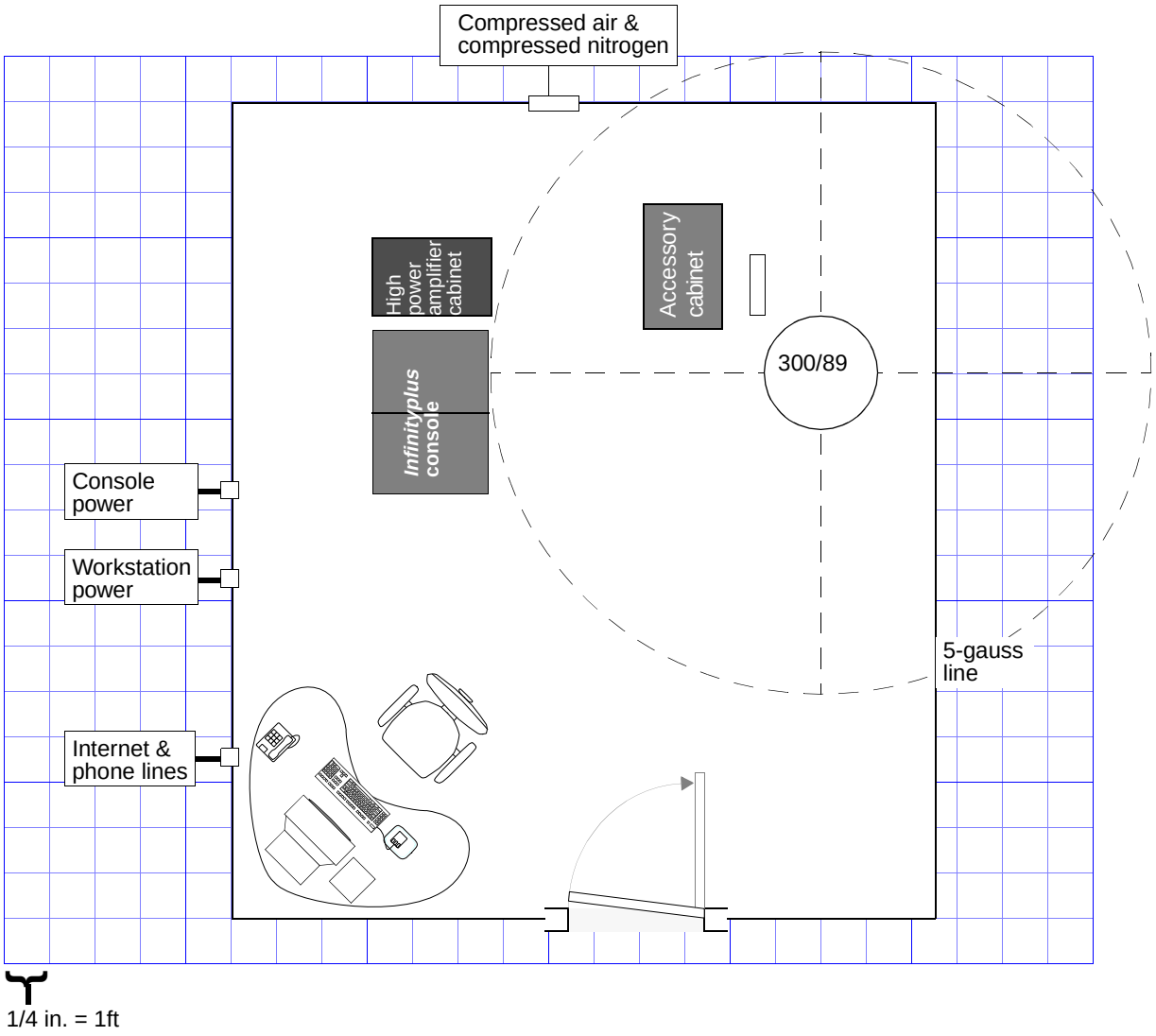
Refer to Figure 6 on page 46 through Figure 12 to find the stray field for your magnetic field strength and scale the layout accordingly.

Minimum Space for a 300/89 System

The room dimensions are about 4.7 m × 5.5 m (15.5 ft × 18.2 ft). The *Infinityplus* cabinet is 111 cm × 78 cm (44 in. × 31 in.). The high-power amplifier cabinet is 55 cm × 78 cm (22 in. × 31 in.) each. The accessory cabinet is 56 x 79 cm (22 in. × 31 in.). Typical table size is 178 cm × 152 cm (70 in. × 60 in.). The magnet is 69 cm × 69 cm (27 in. × 27 in.).

A distance of 1 m (3 ft) should be maintained around the standard cabinet. The magnet should be at least 0.6 M (2 ft) from the wall.

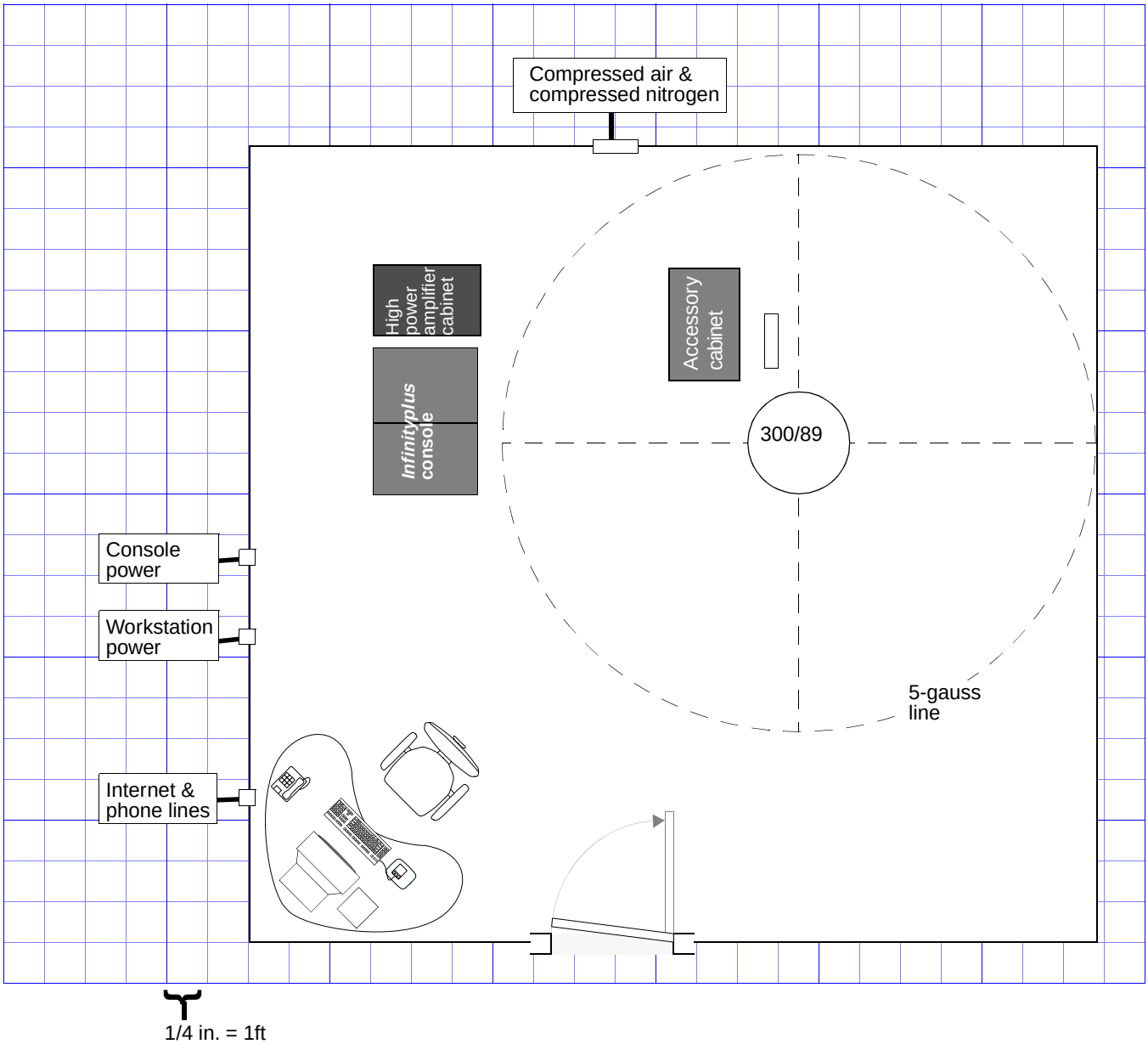
Varian, Inc. does not recommend using “minimum space” configurations due to the presence of stray fields greater than 5 gauss outside the room. If a minimum configuration is necessary, the customer must ensure the safety of people who need to pass through the 5 gauss regions.



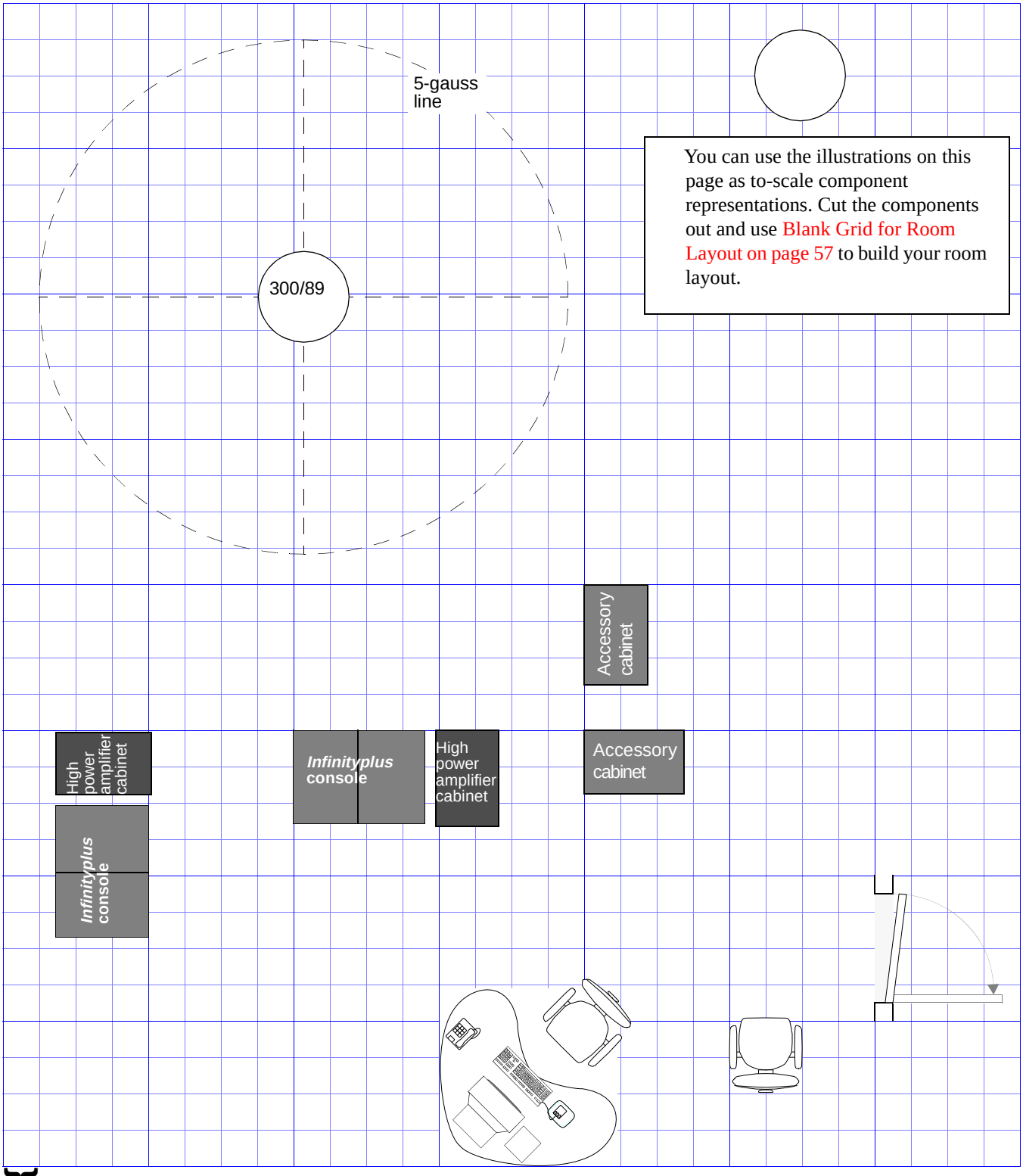
Recommended Room Layout for a 300/89 System

The room dimensions are about 5.9 m × 5.9 m (19.5 ft × 19.5 ft). The *Infinityplus* cabinet is 111 cm × 78 cm (44 in. × 31 in.). The high-power amplifier cabinet is 55 cm × 78 cm (22 in. × 31 in.) each. The accessory cabinet is 56 x 79 cm (22 in. × 31 in.). Typical table size is 178 cm × 152 cm (70 in. × 60 in.). The magnet is 69 cm × 69 cm (27 in. × 27 in.).

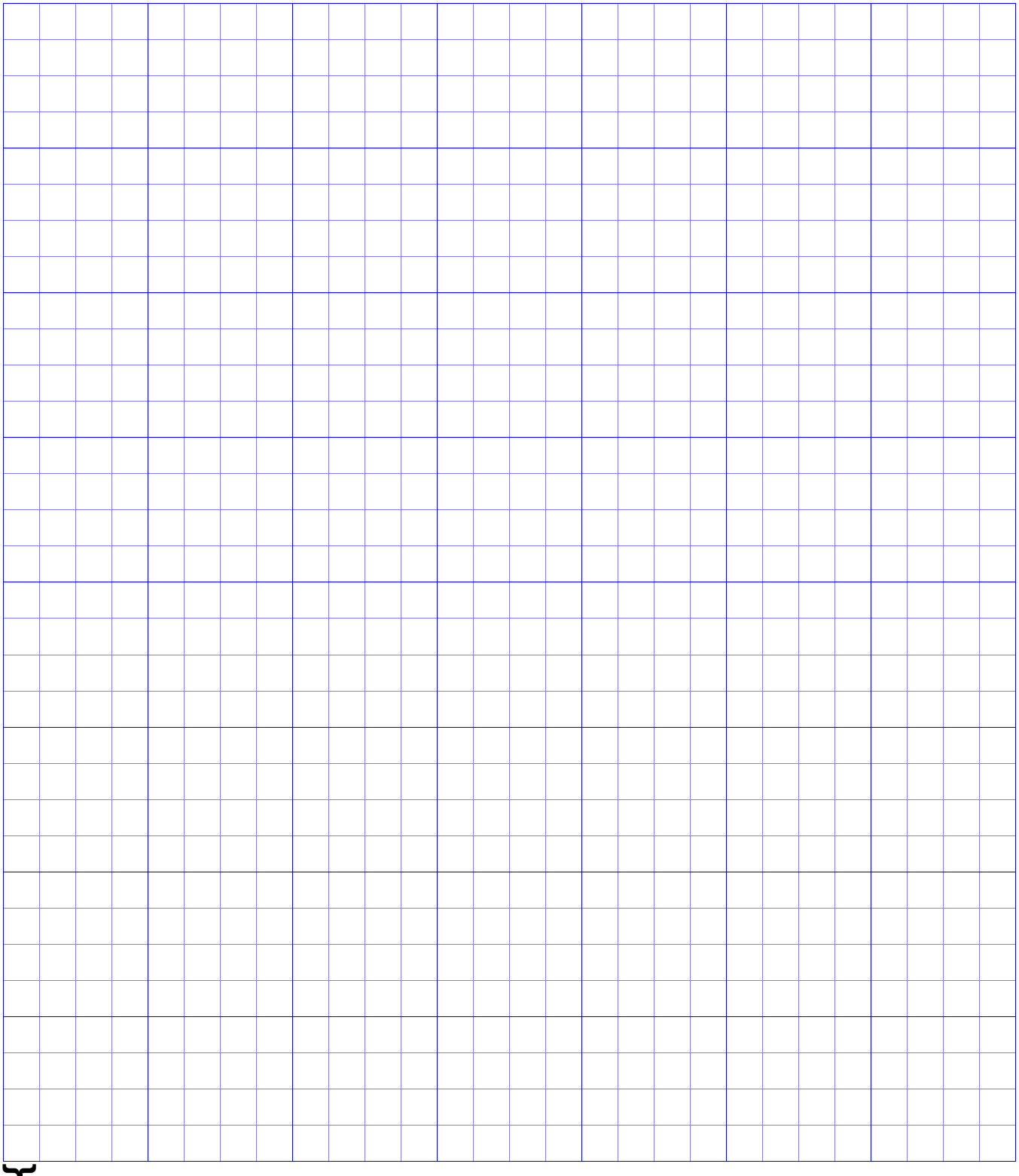
A distance of 1 m (3 ft) should be maintained around the standard cabinet. The magnet should be at least 0.6 M (2 ft) from the wall.



Illustrations for Room Layout


5-gauss line
300/89
You can use the illustrations on this page as to-scale component representations. Cut the components out and use Blank Grid for Room Layout on page 57 to build your room layout.
Accessory cabinet
High power amplifier cabinet
Infinityplus console
High power amplifier cabinet
Accessory cabinet
Infinityplus console
1/4 in. = 1ft

Blank Grid for Room Layout



1/4 in. = 1ft

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